No. 11 1958

THE CANADIAN ASSOCIATION OF GEOGRAPHERS

THE CANADIAN GEOGRAPHER

LE GÉOGRAPHE CANADIEN

L'ASSOCIATION CANADIENNE DES GÉOGRAPHES

THE CANADIAN ASSOCIATION OF GEOGRAPHERS

L'ASSOCIATION CANADIENNE DES GÉOGRAPHES

The objectives of the Association are to promote the study of, and research in, geography. Full Membership, for which the annual dues are $10, is open to any professional geographer. Full-time university undergraduate students may become Student Members for $3 per annum. The annual dues for Associate Membership, which is open to any other person interested in the objectives of the Association, is $5.

Le but de l'Association est de promouvoir l'étude et la recherche en géographie. Tout géographe professionnel, moyennant une contribution annuelle de $10, peut devenir membre actif de l'Association. Pour la somme de $3 par année tout étudiant inscrit comme sous-gradué en géographie dans une université, peut devenir membre-étudiant. Enfin peut devenir membre-associé de l'Association pour la somme de $5 par année, toute personne qui s'intéresse aux objectifs de l'Association.

THE CANADIAN GEOGRAPHER **LE GÉOGRAPHE CANADIEN**

No. 11 1958

CONTENTS — TABLE DES MATIÈRES

Published by — Publié par

THE CANADIAN ASSOCIATION OF GEOGRAPHERS — L'ASSOCIATION CANADIENNE DES GÉOGRAPHES

Price — $1.50 — Prix

In
bour
it is
to in
to a
gions
fied
The
do r
stand
each
strea
and
vel,
teleg
port
prod
estin
effec
(e.g.
each
a po
boun
for e
of th
the
we s
ditio
the
creas
we c
mean
comp
may
of ri
trave
We l
restri
goods
we c
barri
condi
for n
sor i

* T
to the
for a
sible.

THE INTERACTANCE HYPOTHESIS AND BOUNDARIES IN CANADA: A PRELIMINARY STUDY

J. ROSS MACKAY

University of British Columbia

In the study of geographic regions, boundaries are usually drawn even though it is recognized that they may be zonal to indeterminate. If there is any validity to a boundary, then it must separate regions that differ according to some specified criterion, such as terrain or language. The inhabitants separated by a boundary do not, except in very unusual circumstances, live in complete isolation from each other. On the contrary, a constant stream of human interactions flows back and forth across a boundary. People travel, visit, migrate, intermarry, telephone, telegraph, attend schools, send letters, export raw materials, and import finished products across boundaries. If we can estimate, with reasonable precision, the effect of physical and cultural boundaries (e.g. a river or political boundary) upon each type of interaction, we will possess a powerful tool for regional analysis and boundary studies. We might like to know, for example, how a long unbridged portion of the Ottawa River separates or unites the settlements on opposite shores when we specify, or wish to alter, a set of conditions. We can neither remove nor bridge the river, nor can we increase or decrease the size of the settlements, but we can do so in a statistical sense by means of an interactance model and thus compare before and after effects. We may find, for example, that a mile width of river has the same barrier effect for travel as a land distance of 100 miles. We know that the international boundary restricts free movement of peoples and goods between Windsor and Detroit, but we do not know just how effective the barrier is, since we cannot duplicate the conditions without a boundary. Perhaps, for many types of human activities Windsor is, in geographical terms, nearer to Vancouver than to Detroit. The interactance hypothesis provides us with one approach to such boundary studies. It is the purpose of this paper to suggest the use of the interactance hypothesis in boundary studies in Canada and to discuss a non-linear form of the interactance model.

THE INTERACTANCE HYPOTHESIS

The interactance hypothesis has been defined most fully by S. C. Dodd whose model is shown in equation (1).[1]

$$I = \frac{KTP_AP_BA_AA_B}{D} \qquad (1)$$

I stands for interaction. It is nearly as varied in type as are the activities of man. Interactions may be economic, social, educational, recreational, and so forth. Trade between two cities is an economic interaction; migration between two cities is a social interaction; attendance at a university is an educational interaction, or so we are prone to think; and the visit of a tourist to a park is a recreational interaction. Interactions are measured in the appropriate units, such as dollars or number of people. K is a constant. It is the reciprocal of the total number of interactions of the groups concerned. T is the time element, such as a day or a week, over which interactions are measured. P_A and P_B are the populations of the two interacting groups. Population is used in the statistical sense where it refers to an aggregation of elementary units, such as number of people employed in manufacturing or volume of trade, and not in the restrictive sense of the total number of people within a given area. A_A and A_B are the specific indices of per capita activity of the populations P_A and P_B; examples would be average income per person or acreage of wheat per farm. D is a space dimension. It expresses distance or nearness and might be

* The writer would like to express his thanks to the Canadian Social Science Research Council for a grant-in-aid which made this study possible.

measured in miles, cost per mile, ease of access, time of travel, and so forth. The space dimension is particularly geographic, because it involves the concept of distribution.

In order to construct and test an interactance model, it is desirable to have at least 10 to 15 observed interactions. A group of 5 populations can combine in 10 different ways to give 10 interactions; a group of 6 can give 15 interactions. Interactions among a minimum of 5 to 6 population groups should therefore be investigated before a statistically valid model can be constructed.

The interactance hypothesis is based upon the observational fact that groups of people tend to interact more as they become larger, nearer, and more "intense" in their activities. To illustrate with a familiar example, if other things are equal, we would normally expect to have more automobile traffic (i.e. interaction) beween large cities (i.e. large P_A and P_B) than between small cities; between cities with a high percentage of automobiles per capita (i.e. high values of A_A and A_B) than with a small percentage of automobiles per capita, and between cities connected by paved highways (small D) rather than dirt roads. The interactance hypothesis enables us to study such interactions by means of a theoretical model that expresses the relationships existing among the variables of the types just mentioned. The hypothesis, in modified form, has been used in theoretical and applied studies in several disciplines, examples being: Stewart's potential of population;[2] Reilly's law of retail gravitation;[3] Ravenstein's laws of migration;[4] and Zipf's $\frac{P_1P_2}{D}$ element.[5]

Interaction as given in equation (1) is assumed to vary directly with time, population, and activity, but inversely with distance. If population is doubled, interaction is doubled; if distance is doubled, interaction is halved. However, this may not be the case. It is quite possible that a population of 10,000 might generate more or less than twice the number of interactions of a population of 5,000. Likewise, a separation of 100 miles might exercise more or less than twice the effect of a separation of 200 miles. These possibilities should be examined. F. C. Iklé has tested an equation in which the exponent of P was 1.0. He then solved for the exponent of D, obtaining values of from .689 to 2.57 for certain airline and automobile traffic in the United States.[6] In a study of intercity travel desire recently completed at the University of Washington, various *predetermined* combinations of exponents for P and D were tested to see which gave the highest coefficient of correlation.[7] It was found that the square root of the population and the square of the distance yielded the highest coefficient of correlation for the several combinations tested. Swedish studies on migration have given values of the exponent of D of from 0.4 to 3.0.[8] There is good evidence, therefore, to show that the exponent of D might range considerably above or below 1.0. Less attention has been paid to the exponent of P, but there is also the possibility that it too might vary appreciably from 1.0. If the exponents of P and D can both vary from 1.0, equation (2) will represent the general case, of which equation (1) is a special case.

$$I = \frac{KTP_A{}^M P_B{}^M A_A A_B}{D^N} \qquad (2)$$

Iklé has discussed a method of solving for the exponent of D with 1.0 as the exponent of P.[9] His solution may be extended to cover the more general case of equation (2) by taking logarithms of both sides and then fitting a linear regression to the logarithms of the values by the least squares method. The unknowns, namely M and N, may then be determined. It needs hardly be emphasized that the derived values of M and N are not necessarily correct. There should be rational grounds for accepting the statistical results obtained before they are applied in further studies.

For a great many interactions, a simplification of equation (1) is quite adequate. By measuring interactions over unit time for areas with similar intensi-

ties of activities, T, A_A, and A_B may be disregarded and equation (1) reduced to equation (3).

$$I = \frac{KP_AP_B}{D} \qquad (3)$$

THE INTERACTANCE MODEL AND BOUNDARY STUDY

In order to demonstrate the use of the interactance hypothesis in boundary studies, let us assume: 1) that equation (1) has been computed for a given interaction between pairs of Quebec cities; and 2) that the observed interactions between pairs of Quebec-Ontario cities comprise about 20 percent of the interactions that would be obtained if both cities were in Quebec. The drop in interaction of 80 percent is then a measure of the interaction differential between Quebec and Ontario. The reduced level of interaction across the interprovincial boundary might result from several factors acting singly or in combination. For example, only a portion of the population of each Quebec-Ontario city might interact with the other; the activity of each Quebec-Ontario city might be reduced when they interact; or the distance factor might be increased in crossing the Quebec-Ontario cultural boundary. The interactance hypothesis does not identify which variables contribute to the lessened activity; more information is required to identify the model.[10] Even though the causative factor is unknown, the fall-off in interaction between Quebec-Ontario cities, as compared to Quebec-Quebec cities can be expressed in terms of the distance factor D. In the present example, an Ontario city interacts with a Quebec city as if it were five times as far away as it really is by comparison with a Quebec city of the same population and separation.

Boundary effects for two types of interactions are shown in Figures 1 to 5. The interactions which have been used

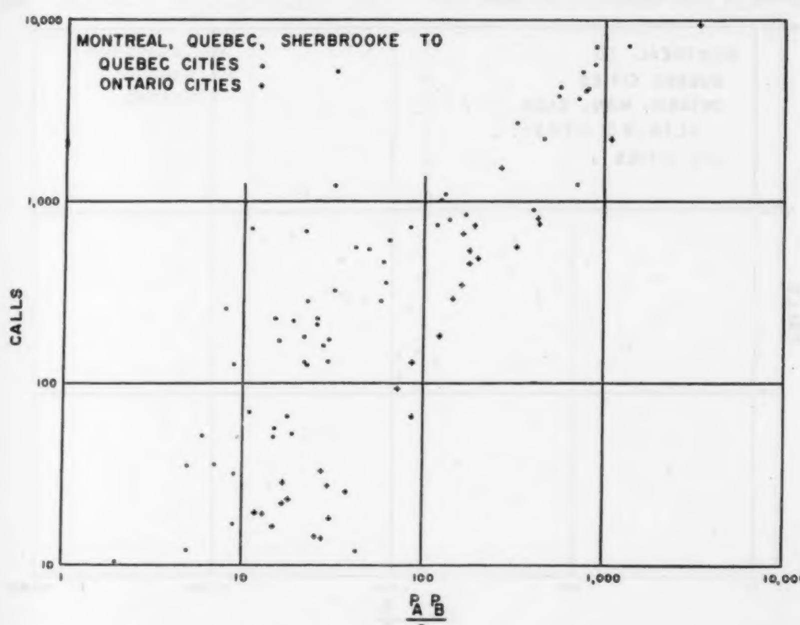


FIGURE 1

are volume of long distance telephone traffic and marriages. These particular interactions were chosen because: other studies have shown that they follow, in general, the $\frac{P_A P_B}{D}$ relationship;[11] the raw data was obtainable; and the data linked places that were geographically far apart, such as Vancouver and Quebec city.

Long distance telephone traffic was obtained through the courtesy of the telephone companies concerned. Only traffic originating at Montreal, Quebec, and Sherbrooke has been plotted in the accompanying graphs but similar results were also obtained in studying the flow patterns for Toronto, Vancouver, and Winnipeg. In most cases, destination data was obtained for at least 50 of the largest cities in Canada and 20 of the largest in the United States. Ideally, it would have been desirable to have separated long distance telephone traffic first into day and night calls, and then according to the purpose of the calls, e.g. business, personal, and administrative, but the data was unobtainable. In addition, the populations served by toll centers could not be precisely determined, but evidently city and toll center populations are numerically similar. Not all of the stations, for which destination data was obtained, appear in Figures 1 to 5, because the volume of traffic to some cities was too small to plot on the scales that have been used. In order to have the figures as unencumbered as possible, no "units" are shown for the x-axis, because any unit system is purely arbitrary, depending upon the measures used for P and D. What is important is the pattern or scatter of the points and the slope of the trend, these being independent of the system of units used.

Long distance telephone traffic originating at Montreal, Quebec, and Sherbrooke for the same 10 day period in 1956 is shown in Figure 1. Total number of calls is plotted on the ordinate; $\frac{P_A P_B}{D}$

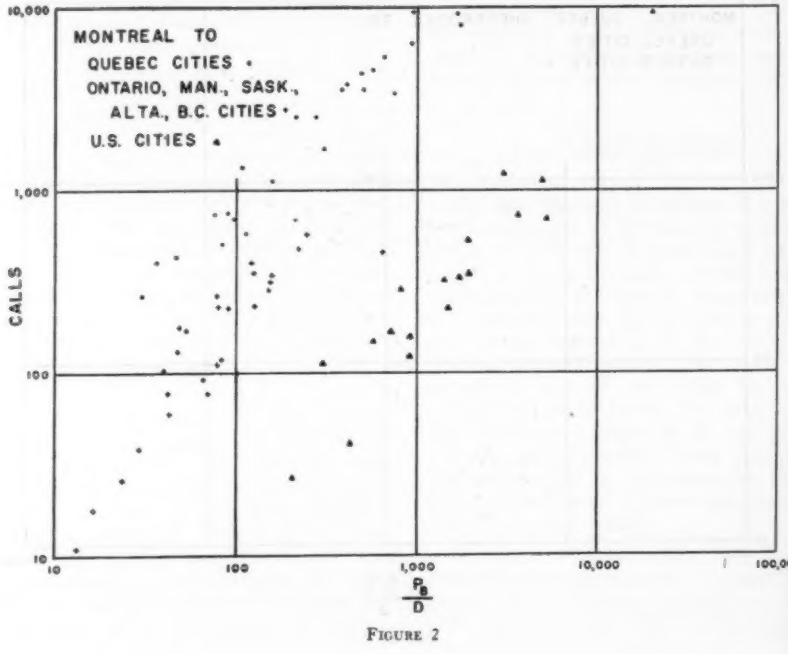


FIGURE 2

along the abscissa. P_A is the city of origin, namely Montreal, Quebec, or Sherbrooke. P_B is the city of destination; these are the 17 largest cities in Quebec (excluding the city of origin) and the 10 largest cities in Ontario. Straight line distance in miles was used for D. Attempts were made to introduce cost factors for D, but since traffic was not separable into day and night calls which vary in rate, cost factors were unsatisfactory. Despite the generalization introduced by using origin-destination straight line distance for D, the agreement in results indicates that it is a reasonably satisfactory approximation to the true distance factor, whatever it may be. The points in Figure 1 show two obvious trends, one of Quebec cities, the other of Ontario cities. The range in population from Montreal to Grand'Mère, the smallest city plotted, is about 100 to 1, and yet the origin-destination data gives a remarkably consistent pattern. Not only does Montreal's origin-destination data form a pattern by itself, but it is basically the same as that of Sherbrooke and Quebec. This agreement in interaction for cities so diverse in size and function as Montreal, Quebec, and Sherbrooke suggests that long distance telephone traffic tends to integrate overall conditions rather than to reflect a particular interest, such as business or administration. The Ontario cities also show a consistent pattern, but their trend line lies well below that of the Quebec cities. On the average, an Ontario city receives roughly a fifth to a tenth the telephone traffic of a Quebec city with the same $\frac{P_A P_B}{D}$ value. This may be interpreted as a measure of the Quebec-Ontario boundary. The cause of the drop in traffic cannot be determined at present, so it is premature to try to identify the elements in the equation. The fall-off might be due, for example, to a decline in A_A or A_B in crossing the boundary (e.g. some Quebec-Ontario traffic might be carried over teletype lines rather than

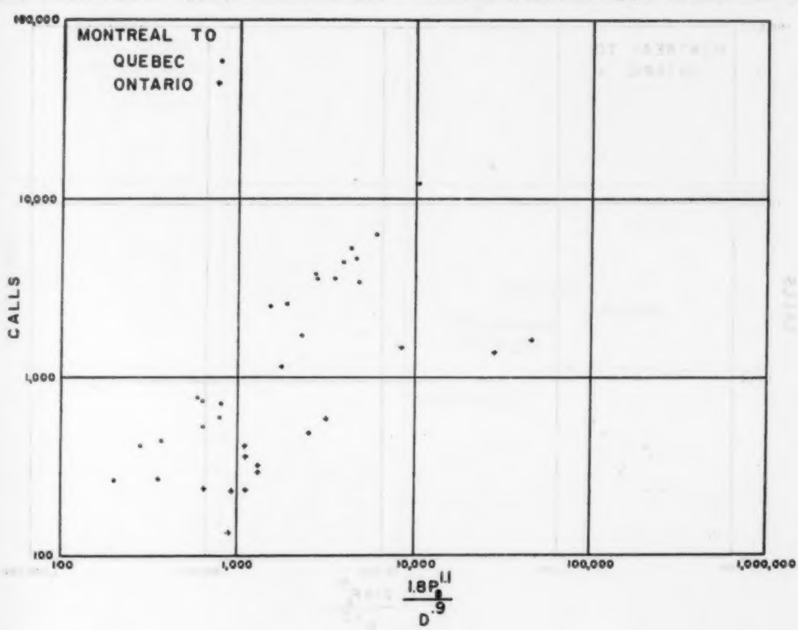


FIGURE 3

telephone lines); to the fact that only a portion of P_A reacts with P_B (e.g. administrative calls are not exchanged between Quebec-Ontario); and so forth. Whatever the cause, an Ontario city reacts as if it were 5 to 10 times as distant as a Quebec city of the same size.

In Figure 2, traffic originating at Montreal for a 10 day period in 1954 is plotted against $\frac{P_B}{D}$ for 22 of the largest cities in Quebec, 29 in the rest of Canada, and 18 in the United States. P_A (Montreal) is common to all, so it has been omitted. Clearly, traffic from Montreal to Quebec cities forms one pattern; traffic to cities in the English speaking provinces a second; and traffic to cities in the United States a third pattern. Traffic from Montreal to nearby English speaking cities like Toronto behaves in the same general way as that for distant cities like Edmonton and Vancouver. The "boundary" between French-English speaking cities may be equated to an increased distance factor of 5 to 10; that of the international boundary to about 50. Thus the French-English boundary is relatively small compared to that of the international boundary, when both are expressed in terms of distance.

In Figure 3, a regression line has been fitted to the Quebec cities shown in Figure 2 on the assumption that the relationship is of the $\frac{P_A{}^M P_B{}^M}{D^N}$ form. $P_A{}^M$ (Montreal) has been omitted, as it is common to all points. The equation reduces then to:

$$I = \frac{KP_B{}^M}{D^N} \tag{4}$$

By taking logarithms of both sides we obtain:

$$\log I = \log K + M \log P_B - N \log D \tag{5}$$

This is the equation of a straight line so that K, M and N can be solved by the least squares method. The values which concern us, namely M and N, are 1.1 and 0.9. These values differ little

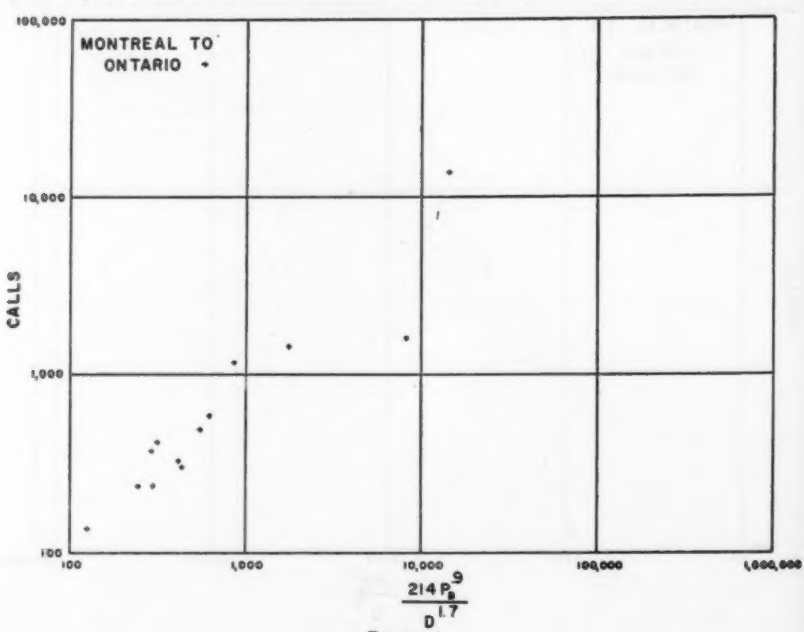


FIGURE 4

from the values of 1.0 used in Figure 2. They suggest that the $\frac{P_B}{D}$ relationship is quite adequate for traffic involving only Quebec cities. The Ontario cities were *not* used in calculating the regression line, but their positions have been plotted upon the basis of the $\frac{P_B^{1.1}}{D^{.9}}$ model obtained for the Quebec cities. The scatter of the Ontario cities is much greater than for the Quebec cities, since the model was derived for the latter.

A regression line calculated for the Ontario cities is shown in Figure 4, the method of calculation being identical to that for the Quebec cities in Figure 3. Exponents of 0.9 and 1.7 were obtained for P and D respectively, that for D differing significantly from 1.0, thus suggesting a non-linear relationship.

In Figure 5, the number of marriages registered in Vancouver, with brides resident in Vancouver and grooms resident in other cities, has been plotted for the three years of 1952 to 1954.[12] The data for the three years has been combined, in order to give larger and more representative totals. Despite the scatter pattern of the cities, marriages of Vancouver brides to grooms resident in B.C. lie within one band; the cities of Toronto and Winnipeg lie slightly below the B.C. band; the American cities of Seattle, Tacoma, and Bellingham also lie below the B.C. band; and the predominantly French speaking city of Montreal lies well below the B.C. band. The trends in marriage data show a greater scatter than for telephone traffic, but this is not unexpected, because relatively small numbers of marriages (e.g. 6 to 10) are involved for many of the places plotted despite the three year total used. Even so, boundary effects are obvious, although the interpretation is another matter, because it involves factors such as language, religion, migration, and age groups.

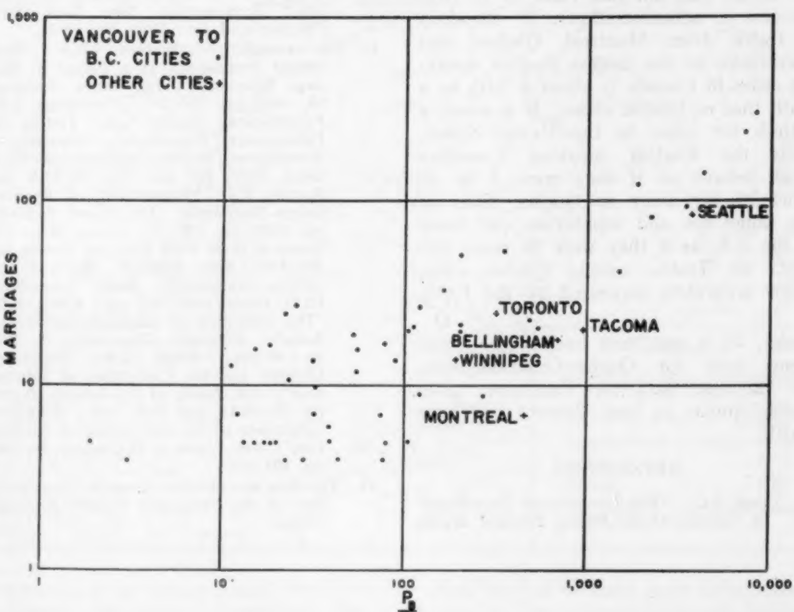


FIGURE 5

As the preceding examples illustrate, the interactance hypothesis may be used to give an expression of boundaries in terms of distance. If many more interactions were used, new meanings could be assigned to the boundaries. The interactance hypothesis provides, of course, only one of many quantitative approaches to boundary studies. Others, such as variance analysis, factor analysis, discriminant functions, and reflexiveness have their unique contributions to make to boundary studies.

CONCLUSIONS

These preliminary investigations show that the interactance hypothesis can be used to study some boundaries in Canada. A number of general conclusions can be drawn as a result of the investigations so far conducted. 1) Since Montreal, Quebec, and Sherbrooke differ greatly in size and urban function, yet show similar patterns in long distance telephone traffic, such traffic seems to sum up the life of the cities, and not one facet of it (e.g. business or administration). 2) the drop in traffic from Montreal, Quebec, and Sherbrooke to the largest English speaking cities in Canada is about a fifth to a tenth that of Quebec cities; it is about a fiftieth for cities in the United States. Thus the English speaking Canadian cities behave as if they were 5 to 10 times as far away as Quebec cities of the same size and separation and those in the U.S. as if they were 50 times distant. 3) Traffic among Quebec cities seems accurately expressed by the $\frac{P_A P_B}{D}$ model. 4) A non-linear form of the model seems best for Quebec-Ontario cities. 5) Marriage data for Vancouver gives trends similar to long distance telephone traffic.

REFERENCES

1. Dodd, S.C.: "The Interactance Hypothesis: A Gravity Model Fitting Physical Masses and Human Groups"; *Am. Soc. Review*, 15, 1950, pp. 245-256.
2. Stewart, J.Q.: "Empirical Mathematical Rules Concerning the Distribution and Equilibrium of Population"; *Geog. Rev.*, 37, 1947, pp. 461-485.
3. Reilly, W.J.: "Method for the Study of Retail Relationships"; *University of Texas Bulletin*, No. 2944, 1929.
4. Ravenstein, E.G.: "The Laws of Migration"; *Journ. Royal Stat. Assn.*, 43, 1885, pp. 167-235; and 52, 1889, pp. 241-305.
5. Zipf, G.K.: 'The $\frac{P_1 P_2}{D}$ Hypothesis: The Case of Railway Express"; *Journ. Psychology*, 22, 1946, pp. 3-8.
6. Iklé, F.C.; "Sociological Relationship of Traffic to Population and Distance"; *Traffic Quarterly*, 1954, pp. 123-136.
7. *State Interest in Highways;* Washington State Council for Highway Research, 2, 1952, pp. 2.1-2.24.
8. Hannerberg, D., Hägerstrand, T., and Odeving, B.: "Migration in Sweden: A Symposium"; *Lund Studies in Geography*, Series B. Human Geography No. 13, Royal University of Lund, Sweden, 1957, pp. 112-120.
9. Iklé, *op. cit.*, p. 129.
10. The problem of identification is frequently encountered in similar studies, e.g. Klein, L.R.: *Econometrics*, New York, Row, Peterson and Co., 1953, pp. 17-18.
11. For example, see: Bossard, J.H.S.: "Residential Propinquity as a Factor in Marriage Selection"; *Am. Journ. Sociology*, 38, 1932, pp. 210-224; Cavanaugh, J.A.: *Formulation, Analysis and Testing the Interactance Hypothesis;* University of Washington, Seattle, unpublished Ph.D. thesis, 1950, 182 pp.; Davie, M.R. and Reeves, R.J.: "Propinquity of Residence before Marriage"; *Am. Journ. Sociology*, 44, 1939, pp. 510-517; Green, H.L.: *The Reach of New York City and Boston into Southern New England*; Harvard University, Cambridge, Mass., unpublished Ph.D. thesis, 1952, 175 pp.; Klove, R.C.: "The Definition of Standard Metropolitan Areas"; *Economic Geography*, 28, 1952, pp. 95-104; Miller, G.A.: "Population, Distance and the Circulatino of Information"; *Am. Journ. of Psychology*, 60 1947, pp. 276-284; and Zipf, G.K.: "Some Determinants of the Circulation of Information"; *Am. Journ. of Psychology*, 59, 1946, pp. 401-421.
12. The data was obtained through the co-operation of the Vancouver District Registrar's Office.

TOWNSITES AND URBAN LAND USE IN SOUTHWESTERN SASKATCHEWAN

M. H. MATHESON

Geographical Branch, Dept. of Mines and Technical Surveys

This paper deals with several aspects of urban geography in southwestern Saskatchewan : the physical setting and some problems which it presents; cultural factors which have helped to influence urban development; and urban land use patterns which have been established as a result of all these factors. These aspects are studied in relation to some of the towns of the area, and to the city of Swift Current.

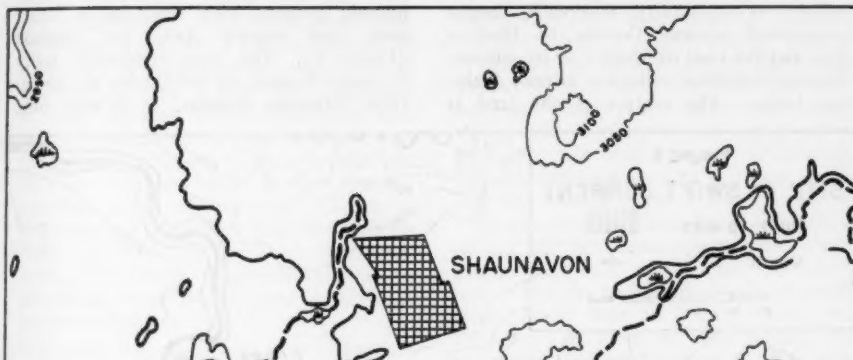


FIGURE 1.
SITE OF SHAUNAVON

Man has had to make great adjustments in order to live successfully on the prairies of western Canada, in towns no less than in the country. Nevertheless, cultural in-

* Presented at the Seventh Annual Meeting of the Canadian Association of Geographers, Ottawa, 1957, and published with the permission of the Director, Geographical Branch, Dept. of Mines and Technical Surveys.

fluences have probably had a greater effect on land use and urban character than have the factors of the physical environment. The physical landscapes of most towns are so uniform throughout, that they have had little effect on a real differentiation of urban land use.

PHYSICAL SETTING AND ITS PROBLEMS

Southwestern Saskatchewan is on the third prairie level — a region of flat to rolling treeless country, watered by deeply entrenched streams flowing to Hudson Bay and the Gulf of Mexico, or by streams flowing in shallow valleys to interior drainage basins. The surface of the land is covered with a thick mantle of glacial deposits of various types. Southwestern Saskatchewan, deep in the interior of North America, forms part of the continental, semi-arid region, known as the short grass prairie, or the High Plains.

Although the terrain of the southwest is not of the flatness popularly ascribed to the prairie provinces as a whole, the towns of the region are usually situated on fairly flat land. In the absence of permanent streams, local drainage is rather poor, and marshy spots are common (Figure 1). The same conditions apply in towns located on tributaries of the interior drainage systems. It is only near

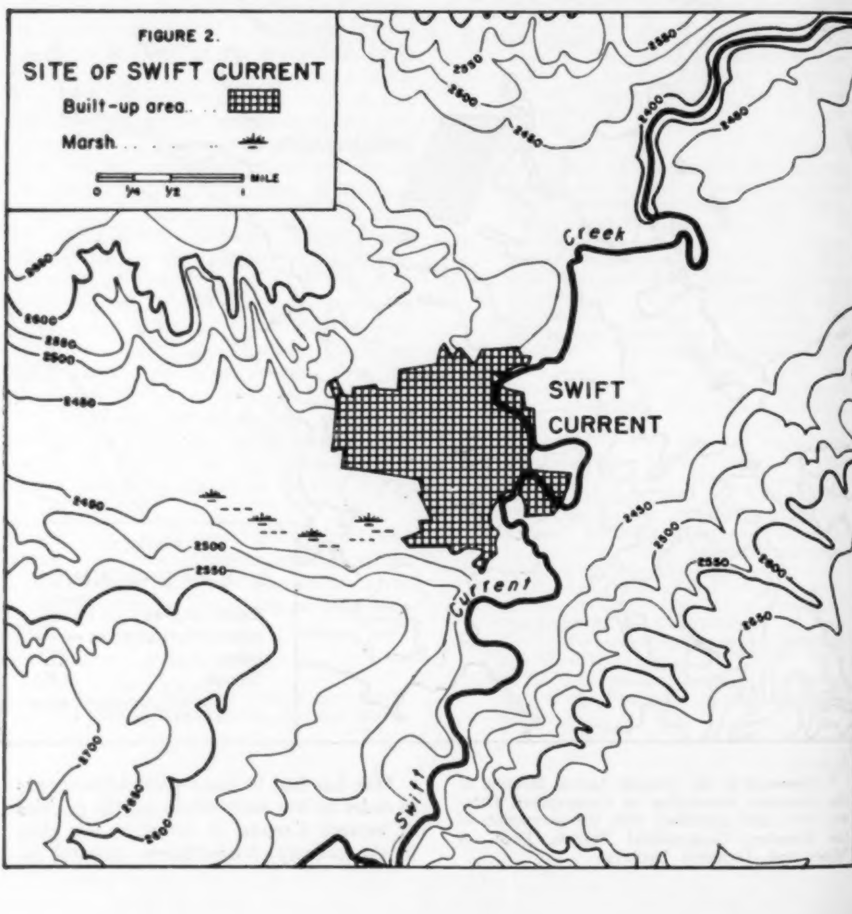


FIGURE 2.
SITE OF SWIFT CURRENT

oceanic tributaries that downcutting is actively proceeding and local drainage is good. Swift Current, located on the slopes of a valley, enjoys good drainage in its higher sections, but the lower parts are poorly drained and are subject to flooding (Figure 2).

The surface deposits of southwestern Saskatchewan are in the form of till or of glacial lake sands, silts and clays. The glacial lake sands are so droughty that few communities have flourished upon them, and most towns are established on soils with a proportion of clay in their composition. The higher this proportion of clay, the more moisture retentive will be the soil, the better the farmland, and the worse the roads. Gravel deposits can be found in such places as the terminal moraines along the Missouri Coteau or the drumlins and eskers near the Cypress Hills, but in many parts of the southwest, especially in the fertile clay plains, gravel for road maintenance is difficult to procure.

Climatic characteristics also contribute to the difficulties of towns in southwestern Saskatchewan. The annual precipitation is approximately 14 inches, but much of it occurs as very heavy showers during late spring and early summer. In some years, the streets are not completely free of mud from the time of the spring thaw until early June. The mud soon bakes hard in the heat of summer, but dust remains a continuing problem until the first snow falls.

The securing and provision of an adequate water supply has been and remains of the greatest importance to urban communities in the southwest. The availability of water for the railways was the factor which led to the establishment of some of the communities. In most of these places, the town was also able to find an adequate water supply, but in others the town must still rely on the railway for its water. The problem is a three-fold one of first finding adequate bodies of water on the surface, in the glacial drift, or deep in the bedrock, of then pumping the water from the deeply entrenched rivers or from deeply drilled wells, and finally of softening the water when it has been obtained.

Sewage disposal also prevents problems. Neither surface configuration nor surface deposits favour good natural drainage, and there are very few bodies of water suitable for sewage disposal.

The inter-related problems encountered by the urban communities of the southwest have been indicated. The prevailing difficulty in their solution is the lack of money, because the region is sparsely populated and is almost wholly engaged in agriculture. Some of the problems have already been solved, sometimes in rather ingenious ways, others have been solved with outside assistance, but many others have, as yet, proved incapable of solution. Not all communities find the same problems the most difficult to solve.

At the present time, Swift Current is one of the few communities which have begun both the installation of storm sewers and the paving of streets, although many towns hope to begin similar programmes. In some of these places, the temporary solution has been to deal with mud, rather than with the conditions which produce muddiness. Concrete cross-walks for pedestrians and ramps on which to park cars have been noticed, as well as concrete retaining walls on either side of the village street. In the town of Eastend, however, local crude oil has been applied to the unpaved streets (Figure 3) to help shed water and control dust. This cheap

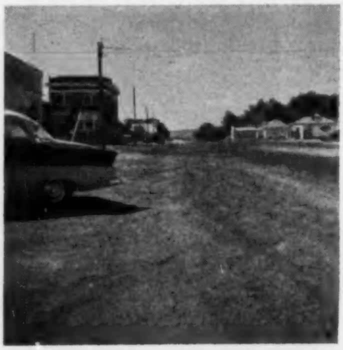


FIGURE 3. The main street of Eastend, Saskatchewan, showing oil applied to the surface.

FIGURE 4. Pacific Street, Maple Creek is a narrower street in an older town. The railway is at the left.

and easy method of tackling the problem is now in fairly general use.

Sewage disposal is a problem to which new techniques are also being applied. Even in communities equipped with sewer systems, some of them laid as relief projects during the thirties, the installation and maintenance of treatment plants has been a costly undertaking. Some towns, such as Shaunavon, are now installing "lagoon" systems which have been found to be cheap and efficient disposal systems for communities of moderate size.

Wells, either public or private, still provide the most common method of supplying water to urban communities. Near the Cypress Hills and Wood Mountain, springs can be tapped. Many villages still have no local supply, and must haul water in carts or trucks from outside points. Swift Current and Assiniboia, among others, depend on dams built under the Prairie Farm Rehabilitation Act, and some other communities depend on water dammed or piped in by the C.P.R. Most towns are able to supply an adequate amount of water for ordinary use, although the quality is not always the best, but few could contemplate supplying water to a population much larger than they now accommodate.

CULTURAL AND SOCIAL FACTORS

Cultural factors have determined the size, shape, and structure of towns in southwestern Saskatchewan. The original townsites were always a mile or half-mile square, representing a section or quarter-section of land. Wherever railway building preceded or accompanied settlement, the streets of the new towns were laid out parallel to the rail line. If settlement and the founding of towns preceded the arrival of railways, the streets were aligned with the survey grid. Prevailing social attitudes also influenced urban landscapes. Towns established during the pioneer ranching period, such as Swift Current or Maple Creek, (Figure 4) have streets of average width. However, many of those established during the great surge of settlement onto the plains, bearing names such as Vanguard, Success, or Climax, have streets

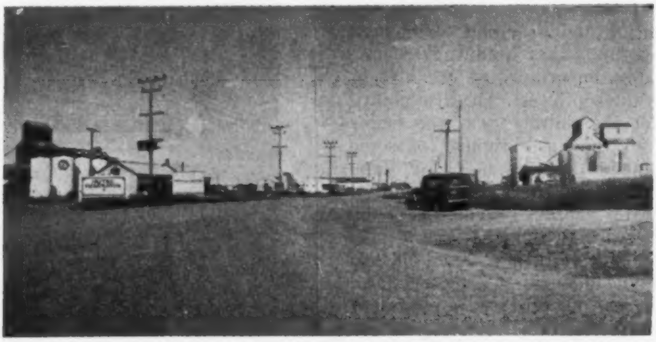


FIGURE 5. Extensive commercial area, Shaunavon. The elevators are on a spur of the railway which is at the right.

FIGURE 6. Centre Street, Shaunavon, is typical of the wide streets in newer towns. The railway is at the end of the street.

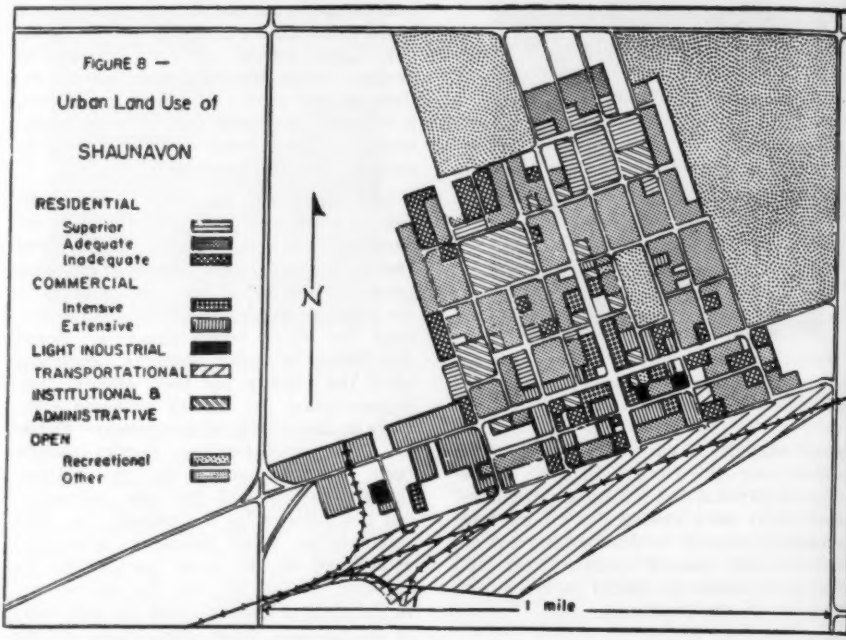
broad enough to carry the traffic of a modern city (Figure 6). In spite, or because of physical and economic difficulties, most towns show evidence of co-operative community action to develop recreational facilities and beauty spots. Parks and tree-lined streets are found in most communities of the southwest.

URBAN LAND USE

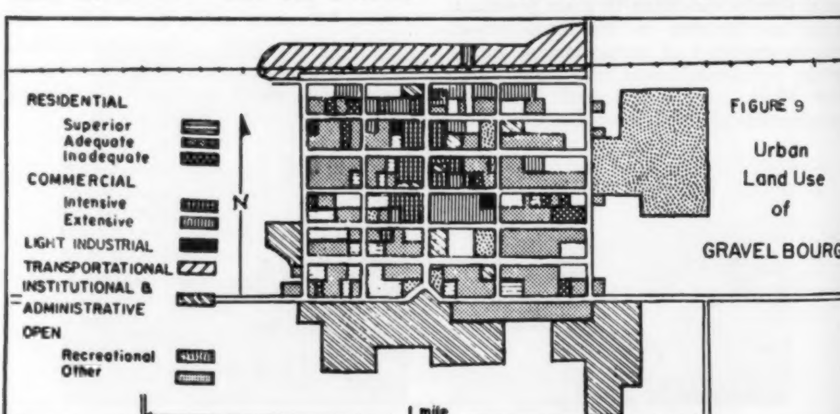
The principal function of the towns of southwestern Saskatchewan is the provision of transportation connections with the rest of the country. In particular, the towns function as exporting points for the great surplus quantities of grain produced. Land use patterns in the towns reflect the pre-eminence of transportation among urban functions. Other functional activities which have direct and immediate relationship with the transportation function occupy what are almost standardized locations in respect to transportation facilities. Given general similarity of physical setting, similar historical and cultural influences, and similar functions to perform, it is hardly surprising that towns in southwestern Saskatchewan exhibit markedly similar land use patterns.

The railway line and its attendant facilities — stockyards and grain elevators for handling outgoing produce, freight sheds and coal yards for handling incoming goods — provide, in the town plan as in the town economy, the base upon which rests the whole urban structure. Retail distributors of bulky products, dependent upon the railway for their supply, congregate along the railway or along highways in the vicinity of the railway (Figure 5). The retail business district usually runs at right angles to the railway though the centre of the town, accessible, but not adjacent to the railway. In older communities, retail businesses were first established on the street parallel to the railway, (Figure 4) but the convenience to shoppers of having stores on both sides of the business street discouraged the use of this type of location. Personal service establishments tend to occupy the same general vicinity as the intensive retail businesses. Skilled mechanical services and light industries gravitate to the same districts as the bulk retail dealers. Most towns, therefore, have three fairly distinct land use zones — the transportation, intensive commercial, and extensive commercial — which are similarly located with respect to one another.

FIGURE 7. Good (left) and poor right) housing on the same street in Swift Current.



A few general principles regarding the distribution of some other types of land use can be observed. The towns provide recreational facilities, medical care, administration, educational and cultural leadership for the surrounding countryside, and are becoming increasingly important as residential centres for farm families. Older facilities such as skating rinks or public schools, are usually located near the centre of town. Newer facilities such as hospitals, district high schools, or



Quonset-style curling and skating rinks, are usually found on the edges of the built-up area, at some distance from the commercial and transportation zones. Administrative offices are located in or near the business district, but court-houses, occupying fairly large grounds, are found towards the outskirts. There is still considerable open land in many townsites, some occupied by cemeteries, or by land used for recreation, and some left vacant because it is marshy.

A noticeable feature of towns in southwestern Saskatchewan is that good and bad housing is often seen side by side (Figure 7). There are often no physical reasons for the development of districts of good or bad housing, and cultural factors are usually responsible for whatever differentiation is visible. Generally speaking, there is no superior housing in the blocks immediately adjacent to the railway, and a higher proportion of inadequate (shack) housing is in these blocks. It is interesting to note that the best housing is usually concentrated in the vicinity of the hospital. Land use in Shaunavon illustrates most of the points

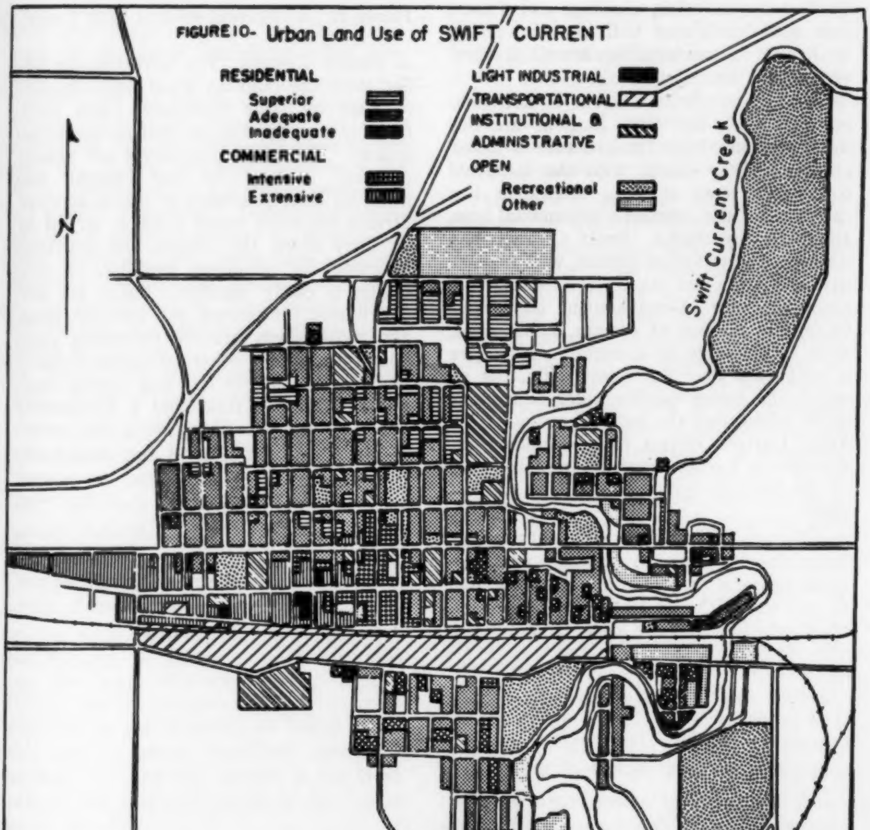


FIGURE 10- Urban Land Use of SWIFT CURRENT

just made with respect to the relative locations of commercial and transportation facilities, the disposition of good and bad housing, and the use of land on the outskirts of the built-up area (Figure 8).

Gravelbourg is more exceptional. It was founded some years before the arrival of the railway, and this fact may account for the development of extensive commercial land use near the centre of the town (Figure 9). More importantly, however, Gravelbourg functions as the educational, cultural, and religious centre for the French-speaking people of southern Saskatchewan. The town has numerous institutions, including a college and a convent school affiliated with the University of Ottawa. These buildings are all situated around the edge of the town.

The city of Swift Current is laid out, essentially, on the same plan as are the towns (Figure 10). Its structure is based on the railway yards, with the intensive commercial area at right angles to the railway and the extensive commercial area alongside the tracks. Swift Current has somewhat more varied terrain, with market gardens, parks and other recreational areas along the river. Good housing has begun to take advantage of certain higher sites, such as the edge of a coulee, which give a wide view over the countryside, but as usual, the better quality older housing is to be found near the hospital (Figure 11). Swift Current differs from smaller communities in having expanded into that part of the townsite lying south of the railway yards.

Although the towns of southwestern Saskatchewan have to contend with adverse physical factors, they have not had to contend with the legacy of poor planning inherited by the older communities

FIGURE 11. A residential street in Swift Current.

of eastern Canada. The townsites are larger than the built-up areas, and are surrounded by large productive farm units, both factors tending to discourage urban sprawl. The towns themselves are usually compact, making for the cheaper and more efficient provision of urban services. Streets are wide, every block is served by an alley down the centre, and provision is made for off-street parking, so that traffic is easily handled. Parks are well distributed throughout the built-up areas, and most towns provide swimming pools and a variety of other recreational facilities. Swift Current has had zoning regulations for some time, and a Community Planning By-law since 1950, the results of which can be seen in the remarkably compact development of the commercial and industrial districts in the city. The towns have not had to invoke zoning regulations yet, but so far they do not seem to be compounding the problems presented by their environment with difficulties of their own making.

THE HISTORICAL RECORD OF MAN AS AN ECOLOGICAL DOMINANT IN THE LESSER ANTILLES

GORDON C. MERRILL

Carleton University

The settlement of the Lesser Antilles in the seventeenth century by people of European and African origin introduced a factor of disturbance into a tropical island environment, with disastrous results in terms of the extinction of living things. A measure of this ecological disturbance is given in the fact that forty-one species of mammals, which belonged exclusively to the West Indies, have become extinct during the past two thousand years, and mostly since the beginning of European settlement. For purpose of comparison, an estimated one hundred and six species of mammals have become extinct in the world at large during the past two thousand years.[1] The statistics on the extinction of birds in the West Indies since European settlement are equally disturbing.[2] In addition, changes in the vegetation have occurred since pre-Columbian time, with the complete elimination of certain species from some of the islands of the West Indies. It is appropriate that we should ask why the record should be so. This paper presents the evidence for the impact of man on the small islands of the Lesser Antilles.

The islands of the Lesser Antilles were indeed part of a New World to the Europeans, and particularly so in terms of biogeography. These small, lush, green islands presented a new habitat, presumably little modified from the natural state by pre-Columbian Indian occupants. The animal population was of marked poverty in number of species. W. D. Mathew studied fossil mammals of the Tertiary for the Antilles as a whole, and concluded that the fauna was composed of a very limited number of types.[3] Mammals common during the Tertiary in North America, such as horses, rhinoceros, deer, and antelope, were entirely lacking in the West Indies. The living mammals of the Lesser Antilles today are also few in number, consisting of two species of oppossum, one armadillo, three agouti, four rats, one raccoon, and twenty-three species of bat.[4] Recent introductions by man are excluded from the list. The significant point is that the fauna of these islands suggests an absence of land bridges to the continental masses throughout geological time, with restriction on entry and a resultant poverty in species. Also, a rather high degree of endemism has evolved in this fauna the result of isolation, as is evident in the twenty-three species of bat in existence today. The circumstance of a small number of species of limited range and small population has invited relatively easy extinction.

The flora is similarly characterized by a poverty of species, with a relatively high degree of endemism, and for the same reason, namely, the isolation of oceanic islands. The worker in the West Indies encounters a luxuriant tropical rainforest differing sharply from the textbook model. The rainforest of St. Kitts is typical of the Lesser Antilles. It is of simple floristic composition, with a strong dominance by a few species; for instance, the upper story of this rainforest is composed of gumlin trees, *Dacryodes excelsa,* to 40 per cent of the cover, mountain cabbage, *Euterpe globosa,* to 30 per cent, and guana sweetwood, *Aniba bracteata,* to 7 per cent. Thus, no more than three species of tree account for 77 per cent of the cover, and no more than another dozen species of minor importance make up the remaining 23 per cent. The vegetation types of the settled lowland area, namely, the secondary forest, scrub woodland and savanna, (Figure 1), exhibit somewhat less poverty in species than the rainforest.

It was into such a habitat that thousands of Europeans and Africans swarmed during the sixteenth and seventeenth centuries. St. Kitts was first settled in 1624

* Presented at the Seventh Annual Meeting of the Canadian Association of Geographers. Ottawa, 1957.

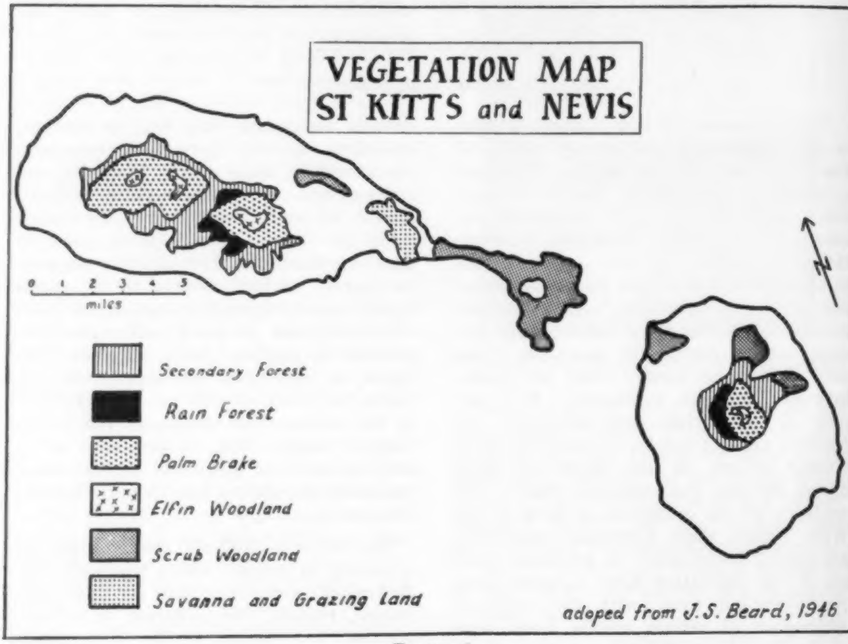


FIGURE 1.

by the English and French, and settlement spread rapidly to the other islands of the Lesser Antilles. Settlers arrived in great numbers. One writer has placed the number of white immigrants up to the year 1644 in the West Indies, chiefly Barbados and St. Kitts, as high as 100,000.[5] Although the figure seems too high, the exodus of white settlers from St. Kitts to Jamaica after 1655 lends some support to the claim of over-population on the former island. It was at this time that sugar became established in a system of monoculture in the Lesser Antilles, and Negro slaves began to be introduced in great numbers. During the thirteen years from 1674 to 1686, the Royal African Company brought 8,000 African Negroes into the Leeward Islands alone.[6] Within a century after the establishment of sugar plantations, the population of St. Kitts had reached 30,000, representing a density of population of 1.6 persons per arable acre. It is significant that such a population has remained stable through the centuries. These basic facts concerning floral, faunal and human populations in the Lesser Antilles invite attention as to the dominance of man as an agent of change.

The Europeans had an immediate need on arrival to exploit local food sources in the Lesser Antilles. The food plants used by the native Indian population appear to have been used sparingly, and somewhat temporarily, by the French and English settlers. Many of the plants out of Indian agriculture, such as cassava, dasheen, and eddo, have failed to win a place on the white man's table. Some of them have become staples in the Negro diet, probably a reflection of the limited opportunity of these folk to exercise a food prejudice. But it was another story with the animal sources of food. It was some decades before the newcomers were able to enjoy the conventional sources of animal protein of the European diet, and the over-exploitation of some local animals of land and sea resulted in extinction or

drastic reduction in numbers.

Land animals were few in the West Indies, and offered little choice to the epicures of colonial society. As early as 1631, observers were reporting on the tastiness of the iguana, *Iguana iguana rhinolopha*, an herbivorous lizard. The iguana is still a food source of some importance in South and Central America. The English settlers on St. Kitts and Nevis liked it, with the result that it became extinct on both islands early in the eighteenth century. The disappearance of the iguana from the islands was noted and explained by the writers of that day as resulting from its superior taste. The frog, *Leptodactylus fallax*, called "mountain chicken" on Dominica where it still exists, was a delicacy in St. Kitts and Nevis during the early years of settlement. It also became extinct on these islands at an early date. The shortage of land animals suitable for food in the West Indies is exemplified by the acceptance of the domestic rat as food during the seventeenth and eighteenth centuries. This common associate of man reached the West Indies as an escapee from the sailing ships. In 1707 Sir Hans Sloane, a medical doctor in Jamaica, and a keen observer of nature and life in the Caribbean colonies, reported that in Jamaica "Rats are sold by the dozen, and when they have been bred among Sugar Canes, are thought by some discerning people, very delicious victuals".[7] There is no record of the white folk eating rats in the Leeward Islands, but the Reverend William Smith in 1720 claimed that "in Nevis some Negroes do eat Rats, wrapping them up in Banano-leaves to bake them as it were under warm Embers".[8] The domestic rat appears to have been a slave food of minor importance, accepted through necessity rather than choice, but there is no record of its use in the Lesser Antilles after the eighteenth century. In summary, two land animals became extinct on St. Kitts and Nevis as a result of their exploitation for food.

The sea offered more and better food animals than the land in the habitat of the Lesser Antilles. Rigorous exploitation during the early centuries of settlement has resulted in drastic reductions in the numbers of both sea turtle and manatee in the Caribbean. With protection, these animals could become once again important sources of food in an area of present need. The theme of this paper dictates attention to the past rather than to the present or the future, but it is noteworthy that a number of conservationists are pleading for recognition of the opportunity presented by the sea turtles and the manatee.

Sea turtles often attain a weight of three hundred pounds, and are a resource of considerable value. There are two species of sea turtle in the Caribbean, the hawksbill, *Eretmochelys imbricata,* and the green, *Chelonia mydas;* the former yields the "tortoise shell" of commerce, and the latter is the source of turtle meat, accepted both as a delicacy in the banquet halls of our latitudes, and as a staple in the diet of common folk in the Caribbean. Our concern is with the green turtle.

The exploitation of green turtles in the Caribbean began early in the colonial period with the British playing a leading role.[9] During the early decades of settlement in St. Kitts turtle meat was an important item in the diet of the French and English colonists. Richard Graecocke, one of the original settlers on St. Kitts in 1624, reported that on that island

> "From May to September, they have a good store of tortoises (turtles), that come out of the sea to lay their eggs in the sand, and are hatched ... They will lay half a peck at a time, and near a bushel ere they are done, and are round like tennis balls. This fish is like veal in taste, the fat of a brownish colour, very good and wholesome".[10]

Graecocke was incorrect in his use of terms, but there is no doubt that he was referring to the green turtle. He went on to elucidate on the method of taking the turtle by turning it over on its back on the beach, and noted that one turtle was sufficient to feed forty people. The historical record of the seventeenth century mentions numerous skirmishes between the French and English on St. Kitts over the right to turtle in the shallow waters

off the peninsula,[11] and reference is made occasionally to turtling expeditions to nearby islands. In Jamaica, the industry soon became big; Sir Hans Sloane in 1688 claimed that some forty sloops from Port Royal were engaged in the industry in the Caymans and in Cuban waters to serve the Jamaican market, where turtle meat "sustains a great many, especially of the poorer sort".[12] Three centuries of uncontrolled exploitation has had a lasting effect upon the range and the numbers of green turtles.

The Atlantic green turtle did not survive in numbers in the waters of the Lesser Antilles long enough to become an important food of the common folk. Today it is seen only occasionally in the eastern Caribbean, and the laying of its eggs on a beach is only an invitation to a hard-pressed peasantry to partake of a meal of turtle eggs. Of wide distribution in the Caribbean as shown in the historical record, the Atlantic green turtle today is found in numbers only in the western Caribbean. The single remaining nesting ground for the green in the Caribbean Sea is along a twenty-mile stretch of beach on the coast of Costa Rica. The seasonal concentration of breeding turtles there is recognized by the coastal dwellers as an opportunity for exploitation and profit rather than for protection and recovery. The present situation is only one stage of a process which had its beginning in the seventeenth century. The final stage appears to have been reached rather early in the waters of the Lesser Antilles.

The story of the manatee or sea-cow is less well known. The animal is a herbivorous mammal which frequently attains a length of over ten feet, and which lives in the shallow coastal waters of bays and inlets in tropical America. William Dampier, buccaneer and author of the seventeenth century, wrote that

"They (the Manatee) live on grass 7 or 8 inches long, and of narrow Blade, which grows in the Sea in many places, especially among islands near the main ... Their Flesh is white, both the Fat and the Lean, and extraordinarily sweet, wholesome Meat. The tail of the young Cow is most esteem'd; but if old both Head and Tail are very tough. A Calf that sucks is the most delicate Meat; Privateers commonly roasts them; as they do also great pieces cut out of the Bellies of the old ones."[13]

Additional factual material is needed on the range and numbers of manatee before the arrival of the Europeans in the Caribbean area. But enough is known to recognize the present restricted range and limited numbers of the animal in the Caribbean Sea. In summary, the exploitation of marine animals for food has not resulted in the extinction of species, but it has impoverished the sea locally as a source of food.

Major disturbances in the fauna have resulted indirectly from the activities of man. For instance, the burning of the vegetation cover throughout the entire area of some life zones on the small islands of the Lesser Antilles, followed by intensive cultivation, destroyed the entire area of habitat for some members of the fauna, especially small rodents and birds. Such an explanation appears to fit many cases of animal extinction in the Lesser Antilles, as for example, the disappearance from the island of Barbuda of a species of muskrat, *Megalomys audreyae*. The fortuitous introduction of the common variety of rat, mentioned earlier, resulted in the disappearance of numerous small rodents from the West Indian islands. These are the events that have swelled the statistics of the extinction of animals, commonly quoted by conservationists. It hardly seems reasonable to take man to task for such events.

Man is however more culpable in cases of the purposeful introduction of predators to control animal populations. The West Indies provide an excellent example of the danger of this measure in the case of the Mongoose. *Herpestes a. auropunctatus*. The story is worth the telling. The common rat had become by the nineteenth century a pest of major proportion on the sugar plantations. In an effort to cut the losses in cane yield resulting from the depredations of this rodent, the sugar planters of Jamaica introduced the mongoose to that island in the late nineteenth century. The mongoose was eminently successful in establishing itself in Jamaica, and within a few years it was carried

purposefully into St. Kitts and the other islands of the Lesser Antilles. The mongoose brought the rat populations of the cane fields under control with dispatch, but this Pied Piper soon began to play some sour notes. The hen house was as exciting to the mongoose as the cane field. More important in the present discussion, the mongoose brought about the extinction of many species of small mammals, birds, and reptiles on the islands of the Lesser Antilles. In fact, by some conservationists, the mongoose is considered to be the real villain in the play. If so, man must be recognized as the playright.

An earlier introduction into St. Kitts is that of the Green Monkey of West Africa, *Cercopithecus Sabaeus*. French soldiers carried the animal into the island as a pet in the seventeenth century, and it promptly escaped into the mountains.[14] The green monkey was a less purposeful introduction than the mongoose, and it appears to have been a less harmful addition to the fauna. Bird populations have suffered as a result of nest robbing by the green monkey, and one species of bird endemic to St. Kitts has been made extinct, namely the St. Kitts bullfinch, *Loxigilla portoricensis grandis*.[15]

The degree to which man has altered the vegetation of St. Kitts and Nevis is not of easy determination. (see Figure 1) The descriptions of early travellers to the islands, and the accounts of early settlers, provide a picture of forest cover reaching in most places down to the sea. In 1608, Nevis was described by Captain John Smith as

> "all woody, but by the seaside southward, there are sands like downs, where a thousand men may quarter themselves conveniently. But in most cases the wood groweth close to the water side, at a high-water mark, and in some places so thick a soft spunge wood like a wild fig tree, you cannot get through it, but by making your way with hatchets."[16]

St. Kitts was described by one of the original settlers in 1624 as being "all overgrown with palmetos, cotton trees, lignum vitae, and divers other sorts, but none like any in Christendom."[17] It is noteworthy that St. Kitts and Nevis were exploited by the English prior to agricultural settlement as sources of logwood. Heavy and selective cutting of Guiacan, *Lignum vitae,* led to its eventual disappearance before the end of the seventeenth century from both islands.

Agricultural settlement made necessary the clearing of forests by burning to provide land for planting. By 1687 Sir Hans Sloane could report of Nevis that the clearing of land extended almost to the top of the central mountain.[18] The forests were also exploited as a source of fuel needed in the production of sugar, and as a result, before the end of the seventeenth century the planters on St. Kitts and Nevis were complaining about the shortage of timber. The clearing of forest to create agricultural land is by no means unique, and it is mentioned for the Lesser Antilles only to complete the record. The savanna and scrub woodland of St. Kitts are worthy of greater attention, for both are the result of modification of the original cover by burning. The vegetation types occurring on slopes below 1000' elevation on St. Kitts and Nevis appear to bear little resemblance to the natural vegetation of the seventeenth century. The juxtaposition of scrub woodland of marked xerophytic quality and luxuriant evergreen rainforest is striking on St. Kitts and Nevis. It cannot be explained as a climatic anomaly, and it seems more logical to explain it in terms of known disturbance by man.

The small islands of the Lesser Antilles presented the incoming Europeans and Africans in the seventeenth century with a new habitat. The occupation of these islands over the past four centuries has exacted a heavy toll on living things. Although man has played an important, and often unworthy, role in the extinction or reduction in numbers of particular Lesser Antillean forms of life, it is proper that all the relevant facts be noted. Endemic species of limited range and small population are typical of oceanic islands. Extinction is made easy by the fact that the ecological niche for any living member of the island habitat is sharply circumscribed, and the way of retreat to an unaffected area following a disturbance

does not exist. A finch endemic to St. Kitts, and the passenger pigeon of North America, are both extinct; clearly, man is more to be condemned for the latter than the former. The unfortunate circumstance of a limited number of living things, and a dense human population on these islands, has resulted in severe disturbances in nature, with a resultant extinction of species.

The historical geographer is interested in the habitats of the past. Changes in the habitat over time invite attention to process. The historical record in the Lesser Antilles clearly reveals man as the major agent of change.

REFERENCES

1. Westermann, J.H.: *Nature Preservation in the Caribbean,* Utrecht, 1953, p. 14.
2. *Ibid,* p. 32.
3. Mathews, W.D.: "Affinities and Origin of the Antillean Mammals"; *Bull. Geol. Soc. Amer.,* 29, 1819.
4. Anthony, H.E.: "The Mammals of Porto Rico, Living and Extinct"; *The Scientific Survey of Porto Rico and the Virgin Islands,* 9, New York Academy of Science, 1925.
5. Newton, Arthur Percival: *The European Nations in the West Indies,* 1493-1688; London, 1933, p. 194.
6. Higham, C.S.S.: *The Development of the Leeward Islands Under the Restoration, 1660-1688;* Cambridge, 1921, p. 165.
7. Sloane, Hans: *A Voyage to the Islands of Madera, Barbados, Nieves, S. Christophers, and Jamaica;* London, 1707; I: introduction, p. XX.
8. Smith, Rev. William: *A Natural History of Nevis, and the rest of the English Charibee Islands in America;* Cambridge, MDCCXLV, p. 23.
9. For a good account of the turtle industry in the Caribbean, see Parsons, James J.: "San Andres and Providencia"; *Universty of California Publications in Geogrphy,* 1956, chapter VI.
10. Churchill, Awnsham and John: *A Collection of Voyages and Travels, some now just printed from Original Manuscripts, others Now irst Published in English;* London 1744-60, 2, p. 54.
11. Harlow, Vincent T.: *Colonizing Expeditions to the West Indies and Guianaa,* 1623-67; London, 1925, p. 96.
12. Sloane: *ibid;* I: XVii, IXXXVII.
13. In von Hagen, Victor W.: *The Green World of the Naturalists,* London, 1951.
14. Labat, J.B.: *Nouveau Voyage aux Iles de l'Amérique;* vol. V, Paris, MDVVXXII, p. 1. Labat reports that "pendant que les Anglois étoient demeurez maîtres des Anglois étoient demeurez maîtres des tencs des François, dont la plus grande partie restèrent en friche, les Singes qui qui s'étoient échapez des maisons des François pendantt la guerre, multplièrent tellement que quand on reprit possission del 'iisle, on les voyoit par grosses troupes".
15. Mestermann: *op. cit.,* p. 15.
16. Churchill: *op. cit.,* p. 344.
17. *Ibid;* p. 342.
18. Sloane: *op. cit.,* vol. 1, p. 42.

POPULATION AND THE ECONOMIC BASE IN NORTHERN HASTINGS COUNTY, ONTARIO *

J. HOWARD RICHARDS

Royal Military College, Kingston

Hastings County stretches from the Precambrian uplands of south-central Ontario to Lake Ontario. The southern third consists of agricultural lands but the bulk of the 1,600 square miles of northern Hastings is on the southern edge of the Canadian Shield (Figure 1). The southern townships were among the earliest occupied in Upper Canada but north ern Hastings resisted general settlement until the second half of the nineteenth century, and even today only about one-fifth (c. 15,000) of the total county population is in these northern townships. The slow extension of settlement and the small numbers of people involved are correctly ascribed to the limited possibilities provided by the physical environment. But, for northern Hastings, this explanation of the characteristics of cut-over marginal land fails to indicate either the variety of resources or to suggest that different resources have varied in their significance to settlement. It fails to explain, also, that changes in population numbers and in the settlement pattern have been continuous and that these changes involved adjustment in both time and area to variation in the economic base. This constant adjustment of population to a changing economic base is the theme of this paper.

PHYSICAL BACKGROUND

Like the rest of the Shield area of south-central Ontario, the rocks of northern Hastings belong to the Grenville sub-province of the Precambrian. In general, these have been characterized by variety rather than by the quantity of associated valuable minerals. Yet mining has been significant throughout the region's history.

Three major land types may be distinguished (Figure 2) and these help in explaining the distribution of agricultural settlement. In the southern part of Madoc, Marmora, and Elzevir townships are limestone till plains, occuring both south of the Shield and on limestone outliers of the Shield. This is the outstanding farming section. North of the till plains, occupying about 500 square miles, is an area dominated by rocky sandy uplands. There is little good land and settlement is meagre, some of the townships, such as Cashel and Lake, having few people, while Grimsthorpe has none. The remaining area, the "rocky ridge and pocket" land type, over 800 square miles altogether, has some better soil. Pockets of deeper sands and silts occur between the Precambrian outcrops. Still, the extent of agricultural soils, particularly of continuous tracts, is small.

Climatically the region is marginal for agriculture. Half, mainly the northern part, where elevations range from 1000 to over 1500 feet above sea level, is subject to a fairly high frost hazard[1]. A sharp reduction occurs in the length of the frost-free season from an average of 126 days at the Shield edge to less than 90 days in the north (in Algonquin Park, frost has been recorded in all months).

Early transportation and power were dependent upon the waterways. The usual "border lakes" occur along the Precambrian contact (Crowe, Moira and Stoco Lakes) while the chaotic drainage of the glaciated Shield is in evidence in the numerous lakes and poorly developed drainage system. Two rivers, the Moira, following to Lake Ontario, and the York, draining via the Madawaska to the Ottawa, have been very important in the history of this section. Both were used in floating timber and, to a more limited extent, were settlement "roads" into northern Hastings.

1780-1850: THE BEGINNINGS OF SETTLEMENT

The period from 1780 to 1820 was not especially important in its imprint on

* Presented at the Seventh Annual Meeting of the Canadian Association of Geographers, Ottawa, 1957.

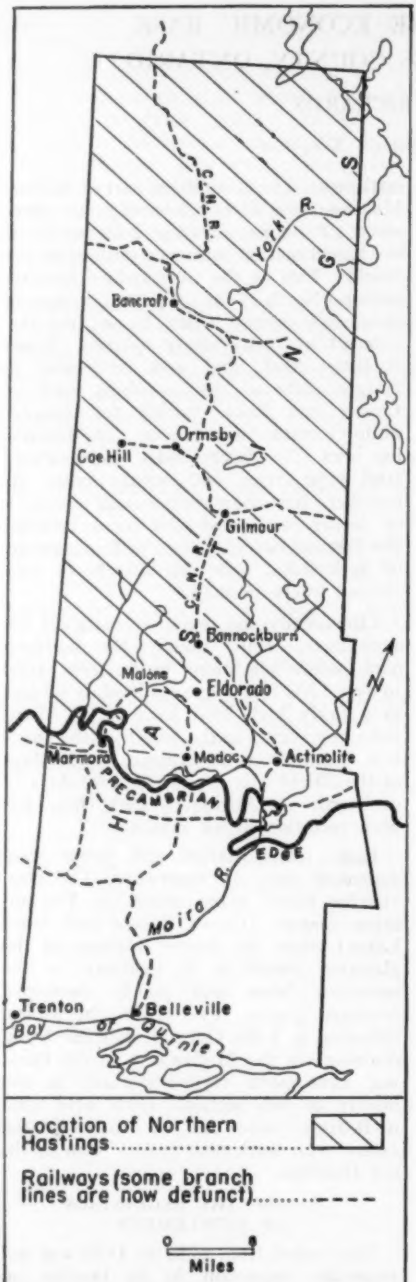


FIGURE 1. Hastings County.

northern Hastings. In the "front" townships, on Lake Ontario, where settlement had been carried out by United Empire Loyalists, gristmills and sawmills had been built and a surplus of grain was being produced by 1820. The country behind was still "Indian Country" and while lumbermen, Indian traders and others entered the back country no direct settlement ensued. It seems likely that timber was being cut along the edge of the Shield and brought down the Moira; also, some prospecting must have occurred, as the Marmora Iron Works were built in 1820, introducing settlement to the border of the Precambrian region prior to the occupation of areas further south.

In 1820, Charles Hayes was granted 1200 acres to build an iron works at Marmora; in addition, he was given a further 1200 acres for fuel and was awarded a contract for iron ballast for the armed ships in the Great Lakes. (Magnetite ore was obtained from the Blairton Mine, a few miles west of the smelter at Marmora.) He spent $30,000 on the works and built a road through twelve miles of wild country from Stirling, on the edge of the settled front, to Marmora. Marmora, Madoc, and Elzevir, the southern line of townships in northern Hastings, were openend to settlement in the following year but no great rush followed.

Excessive cost of transporting pig iron, by wagon at $4 a ton, over a poor road to Belleville, and possibly poor techniques, prevented the iron works from operating economically and they soon closed down. They were sold and modernized; a sawmill and gristmill, together with a village for workmen were erected nearby but the works failed again. Smith [2], in 1851, speaks of a railway and coal supplies as constituting the greatest needs of the industry but, by the time the railway from Cobourg to Peterborough reached the Marmora Iron Mines, in 1854, pig iron from the United Kingdom and from the United States, the entrance of which had been facilitated by the St. Lawrence Canals, had made local smelting non-competitive The Blairton Mine continued shipping ore,

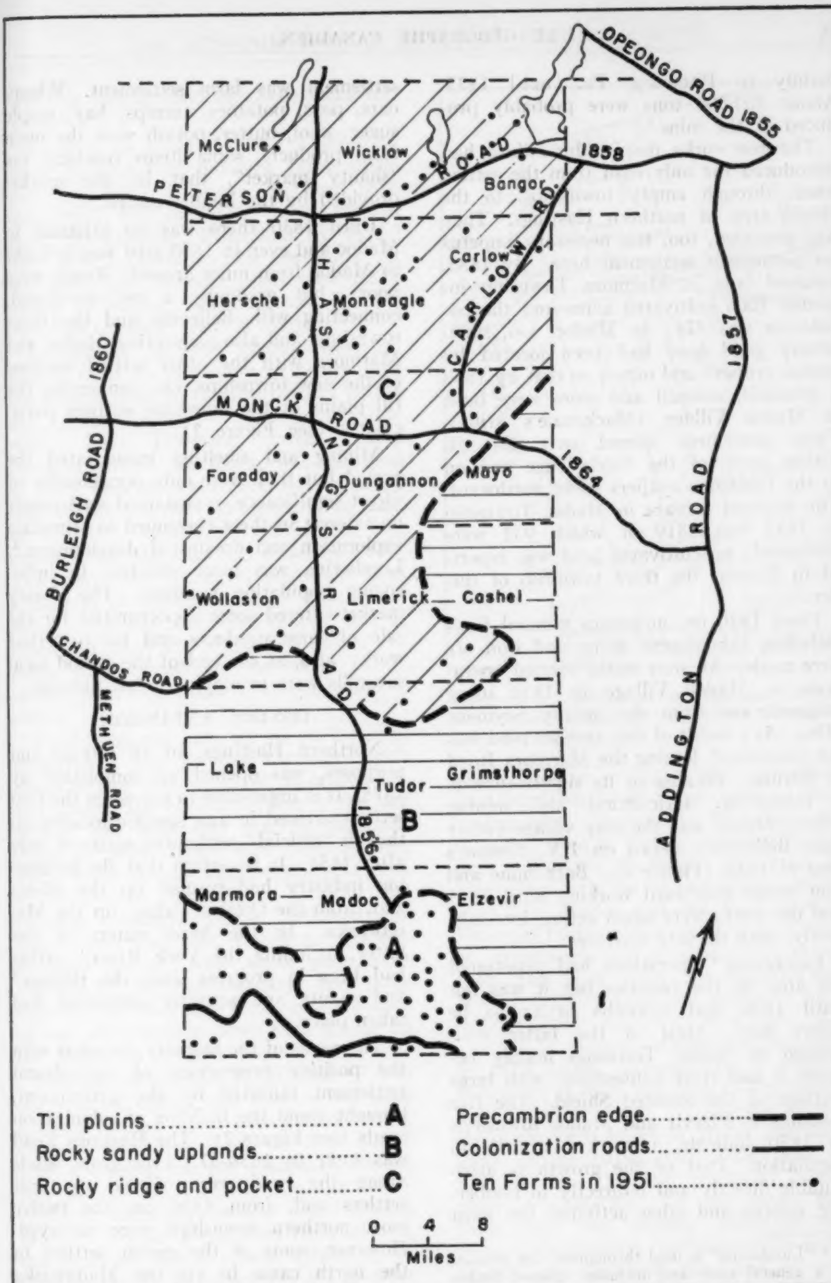


FIGURE 2. Factors in Farm Settlement in Northern Hastings County.

mainly to Pittsburg, Pa., until 1875. About 300,000 tons were probably produced at the mine [3].

The iron works, despite this failure, had introduced the only road from the settled front, through empty townships, to the Shield area of northern Hastings. They had provided, too, the necessary impetus for permanent settlement here. By 1835, assessed land in Marmora Township included 1006 cultivated acres and the population was 273. In Madoc, too, sufficiently good land had been located by timber cruisers and others so that by 1830 a gristmill, sawmill and store were built at Madoc Village (Mackenzie's Mills). Farm settlement spread over the till plains, south of the Shield edge and on to the limestone outliers lying northward. The assessed acreage in Madoc Township in 1835 was 8819 of which 932 were cultivated; no cultivated land was reported in Elzevir, the third township of this tier.

From 1820 on, numerous mineral finds including lithographic stone and iron ore were made. An iron works started operations at Madoc Village in 1836 using magnetic ore from the nearby Seymour Mine. As a result of this another road was cut southward, joining the Marmora Road at Stirling. Because of its significance as a lumbering, agricultural and mining centre, Madoc was the only village (other than Belleville) shown on P.V. Elmore's map of 1836 (Figure 3). Both mine and iron works continued working until 1845 and the works were again active, intermittently, until the late seventies.

Lumbering * operations had penetrated the area by the twenties but it was not until 1830 that sawmills began to be active here. Most of the latter were located in Madoc Township mainly because it had river connections with large sections of the forested Shield. The five sawmills in Elzevir and Madoc townships in 1850 indicate a marked growth in population. Part of the growth is attributable directly and indirectly to lumbering, mining and other activities but most settlement was farm settlement. Wheat, oats, peas, potatoes, turnips, hay, maple sugar, wool, butter, potash were the main farm products, some items reaching the "shanty market", that is, the market provided by the lumber camps.

Until 1830 there was no gristmill in Madoc and even in 1850 grist was brought to Madoc from miles around. Roads were poor — but gradually a net developed, connecting with Belleville and the front townships and also connecting Madoc and Marmora with the other settled sections of the new townships, i.e., connecting the till plains of the limestone outliers particularly (see Figure 3).

Mining and smelting inaugurated the period but they were only occasionally of direct significance to sustained settlement; an interest in them continued to stimulate exploration and dreams of development [4]. Lumbering was more effective in influencing population numbers. The shanty market offered some opportunities for the sale of farm products and for part-time work; also, at the end of the period local sawmills were employing a fair number.

1850-1875: EXPANSION

Northern Hastings, to all intents and purposes, was opened up completely by 1875. It is impossible to say when the first settlers arrived in any specific locality although "official" settlement occurred only after 1856. It is certain that the lumbering industry had pushed up the Moira and, from the Ottawa Valley, up the Madawaska. In the head waters of the latter, including the York River, cutting had been in progress since the thirties [5] and shanty and squatter settlement had taken place.

The needs of the industry, together with the positive programme of agricultural settlement initiated by the government, brought about the building of colonization roads (see Figure 2). The Hastings Road was built in 1856-57. Free grant lands along the road were offered to farm settlers and, from 1857 on, the twelve most northern townships were surveyed. However, some of the earlier settlers to the north came in via the Madawaska from Renfrew County and some came into

* "Lumbering" is used throughout this account as a general term and includes squared timber operations.

Mayo as late as 1880 by canoe along this route.[6]

There is no doubt that the colonization roads succeeded in inducing farm settlement into north Hastings. Between 1856 and 1863, 686 locations[7] were entered along the Hastings Road and by 1871[8] there were 2,716 in the new townships. At the latter date, however, there were 6,571 people in Madoc, Marmora and Elzevir, over half of whom were in Madoc.

Differences in land quality were effective, from the beginning, in determining the general areas of farm settlement within the region opened by the colonization roads. Lake Township, north of and contiguous with Marmora, was surveyed in 1827 but no settlement was recorded here or for the two townships lying east, up to 1850. Indeed, except for the free grants along the Hastings Road in Tudor Township, there has never been more than a handful of settlers in these three townships. This last statement is true, too, of much of Cashel and Mayo Townships. All these are situated on the rocky sandy upland land type where good farmland is scarce.

Lumbering was entering its peak period of activity. The Bronson Company, with headquarters just south of Bancroft, began logging the central section in the late sixties, and with this activity Bancroft began to grow. Logs were floated down York River to the Madawaska and then to the Ottawa (to mills at Arnprior and Ottawa); squared timber followed the same route and was rafted to Quebec. Squared timber, with white pine most important, led the industry and large quantities of this and scores of thousands of logs were brought down each spring, on the Moira, to the lake front.

Mining discoveries continued — iron ore, marble, copper and lead — but their greatest impact came with the discovery of gold in Madoc. This, the first quartz gold discovery on the Canadian Shield, was at the Richardson Mine in 1866. Quickly, Eldorado became the "rendezvous . . . of gold adventurers from all over the continent and a village sprung up as if by magic"[9]. The discovery led to other small finds near Madoc, Deloro, and else-

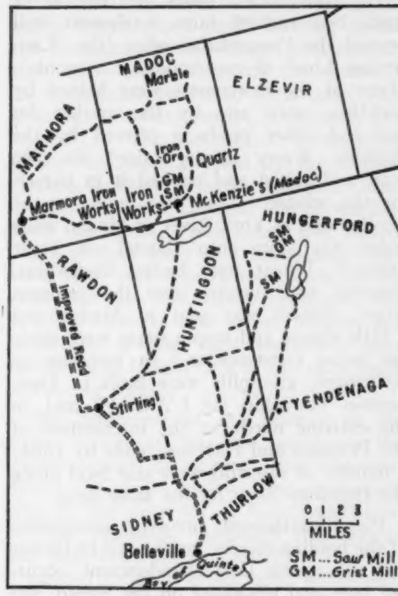


FIGURE 3. Settlement in Hastings County, 1836 (Based on Map of the Midland District by P. V. Elmore).

where but the activities and exploration resulting from "gold fever" were of more consequence. Northern Hastings was booming; even at Detroit and Buffalo the Great Western Railway, indicating its connection with the Grand Trunk, advertised "To Madoc and the Gold Fields". The gold finds petered out but at Eldorado, Bridgewater and at other points, quartz mills had been built "on expectation". Mining activity increased demands for a railway into northern Hastings. The attempt to connect Madoc and Kingston in 1870 failed, although the railway is shown on at least one map of the period, but efforts persisted. A number of iron ore mines were active in Madoc and Marmora in the fifties and sixties and for a short time the iron works at Madoc were in operation. Of the many gold finds only the Deloro, Eldorado and Bannockburn mines continued to be worked for any length of time and at none of these was production considerable.

The colonization roads and free grant lands had enticed farm settlement well beyond the Precambrian edge (the "Laurentian Line" of contemporary accounts). Many of the newcomers were helped by part-time work and by the market for hay and other products offered by the shanties. Every farmer raised his own pork and salted and packed it in barrels for the winter. Wool was taken to the woollen mill at York River or Madoc while some was spun into flannel on home looms [10]. Wheat, oats, barley, buckwheat, potatoes and turnips were the common crops. Potash was sent to Madoc and a little cheese and maple sugar were made for home consumption. In response to settlement, gristmills were built in Dungannon Township (at L'Amable) and, in the extreme north, at the intersection of the Peterson and Hastings roads by 1864; a number of sawmills were also built along the Hastings Road by the same date.

Pseudo-settlement, involving occupation of the holding merely for the sale of timber and subsequent land abandonment, occurred here and elsewhere on the Shield, but the bulk of settlement was bona fide. The settlers contended with the same basic difficulties of the environment that confront present day farmers although soil erosion, due to clearing and cropping, has added to the difficulties in some areas. Just as today, the small amount of crop land contrasted with the large area left in rough grazing, including stump and swamp pasture.

This was a time of village growth. Population in Madoc Village was over 900 by 1864 and for a short time following the gold discoveries population was much larger. Well established farming in the surrounding till plains, mining, lumbering, the gravelled road to Belleville and the Hastings Road northward — all had assisted in creating this main village of northern Hastings with its first class stores, hotels, saw-and gristmills, foundry, tannery and cooperage. By 1869, Marmora was a considerable village with a physician, stores and mills while Bridgewater had a population of 500, with sawmill, gristmill, quartz mill and hotel. In the new townships opened by the colonization roads most of the hamlets and villages, including Millbridge, Murphy's Corners, Salem, York River (Bancroft), emerged at this time.

Lumbering was the main factor in the settlement of the northern townships. To a considerable extent it was the pressure exerted by the lumbering industry which had led to the building of the colonization roads in order to bring in cheap supplies; and it was this industry that provided the pioneer farmer with part-time work in the bush, in spring drives and in sawmills and, also, with occasional markets —thus enabling him to persist as a farm settler in a region ill-suited to farming. Mining was especially effective in the southern tier of townships where most of the gold and iron ore finds were made. Mining and lumbering laid the basis for an agricultural population. The location of the colonization roads and the free grant lands along them affected the initial disposition of farms but by 1871 the present pattern of population distribution, based fairly well on differences in land quality, had emerged: in particular, the rocky, sandy uplands were disregarded as possible farm land.

1875-1901: SATURATION

The northern townships were all well settled by the beginning of this period— the success, a little hollow it is true, of the colonization roads was apparent. The shanty market was available and part-time farming and part-time off-the-farm work were commonplace. At the end of the period the square-timber trade, still pre-eminent, was to give way to a variety of timber products including telephone poles, fence posts, railway ties, pulpwood and firewood. River transportation, the York and Moira, remained important to the forest industry to the end of the century.

Madoc was incorporated, with a population of about 1000, in 1878. It was the supply, service and manufacturing centre for northern Hastings and maintained that status for half a century. Cheese factories were present in Marmora, Madoc and Elzevir townships, indicating both the agricultural background of these and the change in agricultural practices, particu-

larly to a dairy emphasis, in the non-Shield part of the county. During the period cheese factories were to be built in many parts of northern Hastings but Madoc and Marmora had already set themselves apart and, despite mining aspirations, they belonged to the well settled agricultural south.

In 1879 the railway connection to Madoc (the Belleville and Northern Hastings Railway) was completed; at about the same time (1880-83) the Central Ontario Railway was built through Marmora, Malone, Eldorado, Bannockburn and Millbridge and, from Ormsby Junction, a spur line connected with Coehill Iron Mines. Salem, the original settlement a few miles west, was thus displaced by Coehill as the main village in Wollaston Township. Some years were to elapse before Madoc was connected with Eldorado. In 1890 the railway was brought in from Napanee to Tweed and later to Actinolite, Queensborough and Bannockurn. Obviously the railways served the southern area—the section of most active mining and extensive farming.

The gold fever was over. Some further exploration occurred and a few unimportant mines opened in Tudor and elsewhere but by 1885 little active gold mining was in progress although prospecting and mining of other minerals occurred. Marble was quarried near Madoc; in Elzevir, at Actinolite (Bridgewater), actinolite was mined, ground, and mixed with tar for roofing purposes, from 1883 to 1904, when the mill dam was destroyed. Further north, the Coehill Iron Mines (1882) began shipping in 1884 and shipped about 50,000 tons during the next three years: there were no great reserves of the magnetite ore and because of the high sulphur content markets were not easy to find.

Lumbering had preceded the settlement roads but the great period of lumbering, reaching a peak between 1870-1890, had waited on the opening of the settlement lands of northern Hastings. The great lumber companies — the Bronson, Rathbun, Gilmour and others — were providing employment for hundreds at their camps in the cutting season and during the spring drives. As a result farming spread and numerous small villages and hamlets grew up — some assuming the names of the companies associated with them (e.g. Bronson, Gilmour, Purdy, Scriptures', Gilroy, etc.). The method of transporting timber was soon affected by the Central Ontario Railway to Millbridge and Ormsby. Rathbun and Gilmour had driven logs down the Moira, Black Creek and Beaver Creek to their mills at Trenton and Deseronto and while the drives continued for some time. the last, down the Moira, was in 1906. Creeks and rivers became less important as logs and cordwood were loaded on to freight cars to be taken south to the big mills.

The projection of the railway to the points mentioned was due mainly to the impetus given by mining. But the continued use of the railway was made possible by the shipment of forest, and later, of farm products. Although the railway had penetrated half of northern Hastings it exerted no great effect upon settlement. The colonization roads already had provided the means of access and already, too, differences in land quality had made themselves apparent. The five hundred square miles of rocky uplands were almost totally ignored for farm settlement, but areas of better soils further north, in the "Rocky Ridge and Pocket" land type, were settled (e.g., the clay area of the Ridge settlement in Wollaston Township although such sections were frequently isolated.

Faraday Township, served by colonization roads until 1900, grew fairly rapidly. In 1869-70 there were thirty residents in Faraday[11]. In 1881 the township population was 392; in 1891 it was 705; by 1901, the year after the railway, it reached 1,339. Bancroft had over twenty businesses in 1897 and L'Amable at this time had two hotels, blacksmith, sawmill and other enterprises. Growth in Faraday was due to lumbering operations and ancillary agriculture.

Bancroft was reached by the Central Ontario Railway in 1900 and in 1910 the latter passed through the Lake St. Peter settlement in the northwest of the county.

North of Bancroft the main line was joined by the "Irondale, Bancroft and Ottawa Railway" which, despite its name, was never completed to Ottawa. The colonization roads, free grant lands and lumbering had introduced the main body of settlers so that by 1881, before the railway, some thirteen thousand people were in the northern townships compared with the peak of 17,000 in 1901.

Agriculture was well established. The shanty market had provided local markets especially for hay and grain. While the market gradually disappeared the opportunities for part-time work off the farm were not all removed. Farming followed the pattern of the southern townships and, while the proportion of improved land always remained low, dairy farming and mixed farming became commonplace. In 1891 [12], a proportionately large acreage was still devoted to grain — about 17,000 acres under oats, 7,000 in wheat, and 2,000 acres in barley while hay occupied similar acreage (about 26,000 acres). Of the root crops, potatoes were the most important. During the eighties the agricultural fair began to appear (the first Wollaston Fair was held at Salem in 1883). Cheese factories became quite common throughout the northern townships, at Bancroft, L'Amable, Bronson, Wollaston Lake (1890) in Monteagle (near Bartlett's Lake in 1887) and in Limerick in 1910. While pseudo-settlement and abandonment had occurred since the early days, rural population and farm population continued to rise. The amount of occupied land, roughly 380,000 acres, attained its peak at the end of the period and fluctuated only slightly for the next thirty years.

Another small flurry of mining occurred toward the end of the century — again mainly in the southern townships. In 1896, a new company developed properties at Deloro and began producing gold and arsenic (mispickel or arsenical gold had been produced in the sixties and seventies) to the value of about $300,000 by 1903. Some new mines were opened in Madoc (Sophia in 1896), and in Tudor (the Craig Mine, 1898) while old claims at Bannockburn (Wellington Mine) were worked for iron pyrites (shipped to Hamilton Iron and Steel Co.); other short-lived mines were opened at Queensborough (silver and antimony as byproducts) and elsewhere. At Sulphide, on the Shield, but south of the areas here discussed, a mine and plant for the production of sulphides began operation in 1900 and has continued, with interruption, to the present day. The plant has for some time produced sulphuric acid.

Around the turn of the century the population reached its peak. Farm settlement had spread as far as it was to go; lumbering had underwritten this settlement but its guarantee was now being withdrawn; the railway had been a response to the needs of the miner and lumberman — it was not truly an instrument of settlement.

1901-1941: REAPPRAISAL

Between 1901 and 1941 rural population declined by 25% and total population by 12%. Table I indicates changes in the number of farm operators for farms of more than one acre in area and in the amount of occupied farmland. Farming remained the backbone of the economy and it was not until the Second World War that the great decrease in occupied farmland or of farm population

TABLE I

FARM OPERATORS AND AREA OF OCCUPIED FARMLAND IN NORTHERN HASTINGS, 1911-1951 [13]

	1911	1921	1931	1941	1951
Operators	2334	2049	1729	1734	1265
Acreage	384,886	433,153	361,305	339,754	230,924

occurred. While farming underwent some changes the farm of the twentieth century was not distinctly different from that of the shanty era. Mixed farming of a semi-commercial or part-time nature continued as a widespread form but now there was greater need to find alternative cash products. For a time the cheese factory held a significant place in the economy, and dairying, particularly summer production of milk, became important. However, the poor soils of the northern townships failed to support a dairy economy and the cheese factory, and the later creamery, disappeared from the scene except in southern tier of townships. In most townships, sixty to eighty per cent of the occupied farmland has remained unimproved, indicating the great area left in bush or rough pasture. Bush grazing has always been commonplace and the shipping of beef cattle (dual purpose types) by train was important for some time. By the thirties, truck collection helped many parts ship beef cattle and cream, and today "beef and summer dairying" summarizes the kind of farming.

Farm abandonment has been commonplace since the early days of settlement but large scale abandonment occurred after the turn of the century, farm operators decreasing greatly in number since 1901 and the area oc occupied farmland after 1921 but especially since 1941.

Lumbering did not disappear but the extent of operations was radically reduced. The only large stands left after 1900 were north of Hastings County so the cutting of smaller trees and the use of hardwoods became common. Northern Hastings still remains significant as a lumbering area and has numerous sawmills scattered through the townships.

Another spate of small mineral strikes occurred after 1900, this time mainly in the central area. In 1902 the Bessemer Mine (Mayo Township) was opened; it operated intermittently and shipped about 100,000 tons of iron ore before it closed down in 1913. A spur line ("Bessemer and Barry's Bay Railway") connected with the main line at L'Amable; some of the ore was concentrated at Trenton, 78 miles south, and exported to the United States. Reserves of one million tons of varying quality (40-60% were estimated in 1914 [14] While this was the largest mine, dozens of small operations, e.g., Childs and Rankin mines, started, but only a few shipped ore. Small gold mines operated intermittently, e.g., Gilmour Mine, Grimsthorpe (1909-1914), Craig Mine (1905-06), and produced small quanties of bullion [14]. Lead, graphite, corundum, feldspar and other minerals were mined at various points but rarely attained any importance. Marble quarries have operated in the Bancroft district since 1908 and supplied the marble used in such buildings as the Parliament Buildings in Ottawa. Some granite has been shipped, also, from time to time.

Bancroft became established as the centre of operations in the north and the new highways constructed because of increased road traffic by the thirties helped consolidate this position. In 1935, Highway 62 (the Faulkner Highway) was built between Bancroft and Madoc; the highway rarely coincides with the old Hastings Road. In 1936 Bancroft was chosen by the Ontario Highway Department as the centre of operations for this northern section and later Highway 28 connecting Bancroft with Peterborough was built. A major east-west highway, Highway 17, through Marmora and Madoc helped guarantee their position. These highways assisted greatly in opening up Hastings to the vacationer and, today, this is a popular tourist area.

While rural population decreased considerably between 1901 and 1941 (15,064 to 11,355) total population in northern Hastings dropped only 2,000 (17,182 to 15,076). Northern Hastings emerged as being rather different from other Precambrian areas in southern Ontario — there was still a comparatively large farm population (7,636). Despite this farm population, the agricultural fairs, the cheese factories and the new creameries had nearly all disappeared by 1941. The apparent dairying emphasis present in the early years of the century has been preserved in the beef/summer dairying eco-

nomy, commercial or part-time, as the basic agricultural form.

FROM 1941 : NEW MINING ERA

The decade 1941-51 is an interesting one. Occupiers of farms decreased by twenty-seven per cent (actual farm population dropped by 1500 to 6118) and the amount of occupied farmland by over thirty per cent — the largest decrease in any decade. Total population reached its lowest point in seventy years but village population increased.

Explanation of these phenomena are fairly straightforward. Farming on marginal land, together with decreasing off-the-farm work opportunities, had proved difficult for some time and the demands for war-time labour in the cities together with the effect of enlistment upon the young people were sufficient in many cases to produce large-scale rural evacuation. Village population increased as a result of new industrial and commercial functions.

The Second World War encouraged widespread mineral prospecting on the fringe of the Shield but, while a number of mines of various types operated, no great finds occurred. However, the considerable interest in iron ore and other properties [15] led to a magnetometric survey in 1949 and in 1950 the Bethlehem Steel Corporation took out options on about 400 avres southeast of Marmora, Drilling proved this to be the largest iron ore body yet found in southern Ontario.

The post-war period saw also an intensive search for uranium. Radio-active minerals had been described previously and some had been mined incidentally since 1929. Between 1953-54 major finds occurred and in 1956 large-scale operations in uranium began. A great deal of exploratory work has been carried out in the vicinity of Bancroft (mainly in Faraday Township and in Cardiff, in Haliburton County) and it is estimated that over 60 million dollars has been invested in the area by mining companies.

The effects of uranium mining have been great. Bancroft has become a boom town — accommodation is taxed and 800 new homes are planned for the village. 4000 acres have been annexed to add to the original 700. In order to ensure that the mines will pay taxes, so helping to carry the town's financial burden, and to preserve its status as a central town it has applied to be declared a mining area. Faraday Mines have bought land in the southeast section of the town and are financing serviced homes which will be rented to employees; two companies plan a new townsite 12 miles to the southeast at Paudash in Cardiff (Haliburton) Township. Other mines have built isolated houses nearer Bancroft. The population of Bancroft increased from 1,126 in 1946 to 1,334 in 1951 and to 1,627 in 1956. Forecasts are optimistic and there is some belief that the town will grow to 5,000. The basic assumption is that uranium mining will be "permanent" and that the town will remain the residential and service centre. Present estimates indicate 2,400 mine workers in the area. Recent changes in building design (a slight trend away from the concrete/steel concept) have again stimulated marble and granite quarrying near Bancroft. Nepheline syenite, a major source of alumina, also may be produced once more.

Madoc, a junction point on the north-south and east-west highways has remained an important service village. It has long been a centre for mining activities and even today its nearby talc quarries, opened in 1899, are still in operation and form the principal source of Canadian talc.

Deloro (population 253 in 1951), no longer a mining centre, continues as a result of the operation of the Deloro Smelting and Refining Company (Canada's only cobalt reduction plant) reducing silver-arsenic ores from the Cobalt-Gowganda district and from French Morocco. About 300 men are employed in producing the cobalt pellets and silver bullion.

Marmora grew from 1,117 in 1951 to 1,407 in 1956 largely because of the iron ore mine in the vicinity and because of the sustained operations of the Deloro plant. The Bethlehem Mine (subsidiary of the Bethlehem Steel Corporation), located two miles east of Marmora, has an

estimated ore reserve of 20-30 million tons of 60% iron content. It is worked as an open pit, thousands of tons of overlying limestone first being removed. A concentrating and pelletizing plant is in operation and in 1956, the first full year of production, half a million tons of concentrate was produced. A spur line connects with the C.N.R. to Picton, on Lake Ontario, from where it moves by water to the Lackawana, N.Y., plant of the Corporation. At full production about 300 are employed in all operations.

This has been an outstanding period of mining. The latter was accompanied by continued farm abandonment, by greatly increased use of tourist resources and by increased recognition of this as mainly a forest region.

Despite a former temporary emphasis on dairying, today dairy products are brought into the area — a repetition of the period when the shanty market was more cheaply supplied in many products by non-Shield Ontario. It seems unlikely that the new mining activity will bring about an increase in the area of occupied farmland, but it may well have the effect of stabilizing farm population in the better sections and of providing new market and work opportunities for both farm and rural population. Mining unlocked northern Hastings in 1820; today it has reopened it.

REFERENCES

1. Spragge, G.W.: "Colonization Roads in Canada West, 1859-1867"; *Ontario History*, XLIX, p. 15.
2. Smith, W.H.; *Canada; Past, Present and Future*, Toronto, 1851, p. 255.
3. Moore, E.S.: *The Mineral Resources of Canada*, Toronto, 1933, p. 55.
4. *Directory of the County of Hastings*, Belleville, 1864-65, p. 19.
5. Spragge: *op. cit.*, p. 2.
6. Smith, A.E., edit.: *In Those Days, a History of North Hastings, etc.*, Bancroft, 1956, pp. 19, 14, 32 et al.
7. Directory of the County of Hastings, *op. cit.*, p. 20.
8. *Census of Canada, 1870-71*, vol. 1, Ottawa, 1873, p. 32.
9. *Directory of the County of Hastings*, Belleville, 1869-70, p. 285.
10. Smith, A.E.: *op. cit.*, p. 30
11. Directory of the County of Hastings, 1869-70, *op. cit.*, p. 60.
12. *Census of Canada*, vol. IV, Ottawa, 1891.
13. *Censuses of Canada* for 1911, 1921, 1931, 1941 and 1951.
14. Thomson, J.E.: "Mineral Occurrences in the North Hastings Area"; *Annual Report of the Ontario Department of Mines*, LII, Pt. III, 1943, pp. 32 and 40-43.
15. Thomson, J.E.: *op. cit.*, p. 37.

PROSPECTS FOR NUCLEAR POWER IN CANADIAN MINERAL INDUSTRIES *

J. U. MOWLL

The Martin Company

It seems clear now that the future of electrical power production from nuclear fission will fall into three periods. The development period will consist of initial operating experience, developing procedures for refueling and maintenance, and testing the effectiveness of health and safety precautions. Once these technical problems of operation are solved, and the industry can offer a product with assured dependability, the second period will begin. This will be the critical period because it is then that nuclear power will compete for markets with the disadvantage of higher costs than power produced from conventional sources — the fossil fuels and water power. Eventually, even the economic disadvantage will be overcome, partly because of improvements in the nuclear power systems and their consequent economics, but mostly because of rising costs of conventional fuels.

As a first approximation, the mills per kilowatt-hour cost concept is a convenient measure of the comparative economic efficiency of one plant over another. The cost of producing electricity, as measured by the mills per kilowatt-hour concept is made up of a number of factors and these are the same for any type of electric plant, nuclear, or otherwise. These include the general category of fixed costs, which include capital costs, amortization, interest, taxes, and overhead. The other general category is operating costs which includes fuel, maintenance. and, if the plant is located some distance from the load-center as is often the case with nydro-electric plants, transmission losses.

Let us take the elements of these costs one by one. The first principle that can be established is: Nuclear power improves its comparative advantage with respect to fuel costs in proportion to the increase in transport costs. Except with respect to hydro-generated power, the chief advantage of nuclear power lies in its comparatively low fuel cost. This advantage is emphasized when transport costs assume an abnormally large share of the delivered price of competitive fuels. Nuclear fuel elements are compact, could be delivered by air if necessary, and have a life expectancy in the reactor of from 12 to 24 months. Compared to this, the competitive thermal power plants, the diesel plant, or the steam turbine plant, require a continuous flow of diesel oil, bunker "C" oil, or coal, with an additional requirement of an investment in capital equipment for handling and transporting them.

The fuel costs of a hydro plant can be thought of as the installation and maintenance costs of the water supply equipment, including the dam, canals, or any other part of the installation that serves to deliver water to the generating equipment. Normally, this is a one-time charge which, when treated as a fuel costs, should be pro-rated over the expected life of the plant. Usually such costs are quite low, and, since they vary so widely from installation to installation, no valid average costs can be computed. It can be assumed, however, that these costs are low enough to be outside the range of effective competition with nuclear fuel costs. Operating costs other than fuel are generally assumed to be the same for all types of generating plants.

The second governing principle in the location of nuclear power plants is: The installation must have a high load factor or utilization factor to justify the high capital cost. The chief economic disadvantage of the nuclear plant is the relatively high capital cost. This is calculated to be in the order of 2.5 to 5 times the capital cost of a steam plant and three to four times that of a diesel plant. The effect of the high capital cost is to limit the installation of nuclear power to those situa-

* Based on a paper presented at the 53rd Annual Meeting of the Association of American Geographers, Cincinnati, Ohio, 1957.

tions where there is a high load factor which will utilize the capital to the utmost.

The capital cost of a hydro plant is usually quite high also, but again, it is difficult to generalize because of the great variations from site to site. However, there is one factor that seems to occur frequently and that is the large capital investment in transmission lines. So many hydro power plants are great distances from the load centers they serve, particularly those outside the old industrial regions which owe some of their origins to the "fall line" concept. For example, the proposed Hamilton River Project is several hundred miles from the existing load centers.

The geographic problem now is to determine where conditions exist in which these factors will influence the location of nuclear power plant.[2] The limitation imposed by the high utilization requirement points immediately to two general situations. One, the large metropolitan complexes where the load fluctuations of residential requirements are balanced by a variety of industrial and commercial customers. Two, the comparatively small, but consistent, requirements of certain industries, which operate on a twenty-four hour basis and thus provide a high base load for an electric generating plant; typical of this type of industry is the integrated mining complex where the mine operates on a two-shift, 16-hours-a-day basis and the ore concentrating mill operates twenty-four hours a day. Such an installation provides a utilization factor for the power plant of from 70 to 80 per cent; an average-sized town in North America may provide 40 to 50 per cent load factor; whereas some plants serving towns in Latin America are assured utilization factors as low as 35 per cent.

Canada makes an excellent example for illustrating the distribution of power costs. It has well-defined metropolitan areas and a well-distributed mining industry, thus meeting the requirement for consistently high utilization factors. The accompanying may shows the distribution of power costs in Canada by lines of equal cost in gradations of five mills per kwh. It shows the regions where nuclear power installations might be placed.

COST OF PURCHASED POWER IN CANADIAN MINERAL INDUSTRIES

Hydo-electric resources in Canada have accounted for 97 per cent of the power produced by public central systems in recent years.[3] Thus power costs in general are relatively low; the average cost of power purchased by the mining industries from public sources in Canada as a whole was 3 mills per kwh. in 1954. On a territorial or provincial basis there is a great deal of variation from the low total average. Power for mining cost about 5 mills or less in the provinces of Quebec, Ontario, Manitoba, Saskatchewan and British Columbia. In the remaining provinces and territories, however, purchased power costs ranged from 9 mills in Newfoundland to 26 mills in the Yukon.

When the figures are broken down into product groups,[4] it is found that the metal mining industries, including smelters and refineries, paid an average of about 3 mills per kwh. for purchased power. The smelters and refineries are favourably located with respect to power and, since they used 86 per cent of the power in this category at an average cost of 2 mills, they influenced the figures markedly. Excluding the smelters and refineries, the balance of the mining operations which include actual mining and milling or concentrating, paid an average of 6 mills. The silver-lead-zinc mines paid the highest price of 10 mills. This probably reflects the trend toward more remote locations as the more conveniently located mines are becoming depleted under the pressure of modern demands for these metals. Zinc, for example, is in increasing demand for die castings in automobiles, appliances, and other high volume consumers goods.

Another interesting point is the high cost of purchased power in the fuel extraction industries. Coal mining, for example, used 250,245,525 kwh. of purchased power in 1954 at an average cost of 14 mills. This amounts to about 18 kwh. per ton for the 13,530,000 metric

tons of coal and lignite mined, or a cost of $0.252 for each ton. Even at this high average cost apparently it is economical for the coal mines to purchase power rather than make it. "...coal mining in some areas makes use of hydro-electricity in preference to pit-head development of fuel power."[5] Coincidentally, most coal mining in Canada is concentrated in those provinces in which the cost of purchased power for mining is above average: Alberta, New Brunswick, and Nova Scotia.

COST OF SELF-GENERATED POWER IN CANADIAN MINERAL INDUSTRIES

The Hydro Situation

Mining companies in Canada operate 19 hydro-electric plants[6] of 2,000 h.p. (1,500 kw.) capacity or larger.* The largest is 240,000 hp. (180,000 kw.) and there are five over 50,000 h.p. (37,300 kw.) which tends to skew the average of 36,200 h.p (27,000 kw.) toward the upper end of the scale.

Closer analysis reveals that these plants fall into three size categories: (1) five over 50,000 h.p., all located in British Columbia. Four of them are Kootenay River developments of the Consolidated Mining and Smelting Company. (2) two in the 20,000 h.p. to 50,000 h.p. range, both owned by the International Nickel Company and located on the Spanish River in Ontario and (3) the remaining 12 scattered throughout Canada with an average size of 5,800 h.p. (4,300 kw.).

Operating costs on these hydo installations is quite low, but few of the companies include capital costs in quoting the cost of power generated. For example, a large plant quotes an operating cost of 3 mills for its hydro generating plant. However, the investment totals $4,088,000 including a 45-mile transmission line. At 10% annual fixed charges, the total cost of power in this situation comes up to 17 mills. In addition, lack of rainfall in recent years has forced the company to install a diesel plant which produces power at an operating cost of 22 mills.

The example cited above underscores several factors which prevail generally throughout Northern Canada and which will become severely limiting factors on the future development of hydro-electric power for the minerals industries. While, in general, potential hydro sites are abundant throughout the regions, specific sites are often at great distances from the actual sites of the mines and mills. This means a large investment in transmission lines which cost in the order of $30,000 per mile. Specific sites outside of the mountainous regions of British Columbia and the Laurentians are not very large and expansion is usually impossible. Of the nineteen hydro plants now in operation in the minerals industries, only four show opportunities for expansion and two of these are in British Columbia. Consequently, as power requirements expand, mine and mill operators will be forced to install auxiliary plants.

Coal-fired Steam Plant

There is only one coal-fired steam plant serving the Canadian minerals industry. This is a 10,000 h.p. (7,460 kw.) plant located at Trail, British Columbia. This plant generates power for 10 mills (total cost) using low-grade coal obtained from company mines located a short distance from the plant.

The Diesel Situation

Diesel electric power is available at almost every Northern Canadian mining establishment, even though the primary source of power may be a hydro-electric plant. Diesel power is used as stand-by power, to supplement hydro power during extremely cold seasons when freezing temperatures interfere with full utilization of the hydro installation, and, as is happening with increasing frequency, to provide power for expansion in cases where the hydro-potential is already fully utilized. Diesel power is used extensively in mobile equipment, so it must be borne in mind that even if nuclear power were to be installed as a primary power source

* These figures do not include the power plants of the aluminum industry. These include over 2,000,000 h.p. on the Saguenay and Peribonka Rivers in Quebec and 450,000 h.p. at the new Kitimat development in British Columbia.

it would not eliminate the need for diesel fuel oil entirely.

The cost of diesel-generated power in Northern Canada is quite high; this chiefly is a function of the high cost of diesel fuel oil in the remote regions. In the Yukon, for example, the price of diesel fuel in Whitehorse in 30 cents per Imperial gallon. At Vangorda Camp, 125 miles northwest of Whitehorse, it jumps to 74 cents. At Keno Hill, location of the largest mines in Yukon, diesel oil is 38 cents per Imperial gallon.

Chief source of oil for the North is Norman Wells on the Lower Mackenzie River. Locations on the Mackenzie River barge system, including Great Bear Lake, Great Slave Lake, and Lake Athabasca, get their oil at relatively low prices. However, the system is open only two monts of the year and these low prices are meaningful only if sufficient storage capacity is available to take care of the requirements for the entire year. For example, oil is delivered to Yellowknife on the Great Slave Lake for 16 cents per gallon. But this price does not include the cost of tremendous storage facilities. The Eldorado mill at Beaverlodge on Lake Athabasca has storage capacity for 4,285,000 gallons. A small mine in the Beaverlodge area, with no milling facilities, maintains 120,000 gallon storage facilities to service its 185 kw diesel power plant.

Another source of fuel in the north is via the railroad to Waterways in northern Alberta and thence by barge up the Athabasca River to Lake Athabasca, and through the Slave River to the Great Slave Lake, thereby connecting with the Mackenzie River system. Transport costs on this route are $12 per ton from Waterways to Beaverlodge on Lake Athabasca and $100 per ton to Port Radium on Great Bear Lake.

One of the newest mining areas to be developed in Canada is the Chibougamau region in northwestern Quebec. Delivered diesel oil sells for 20.5 to 23 cents per imperial gallon.

The cost of generating diesel-electric power follows the oil price pattern very closely. Highest costs uncovered in this study are at Keno Hill in the Yukon where the operating costs of diesel-electric plants come to 48 mills per kwh. At Port Radium they are 26 mills; at Beaverlodge, 30 mills and at Lynn Lake, 22 mills. Complete distribution of diesel-electric operating costs is shown on the accompanying map.

Summary

The outlook for the extensive use of hydro-electric power in the minerals industries presents a confused picture. In some areas in Canada hydro power is so abundant and so cheap it will defy competition for some time to come. In other areas, some of them critical mining areas, the low cost of hydro power is offset by limitations of size, convenience, and reliability. The latter areas seem to hold promise for more versatile sources of power such as diesel or nuclear.

Diesel costs in these regions, however, are quite high. In large portions of northern Canada diesel power generating costs run well above 20 mills and, when full accounting is made for capital costs, the total may well run into the 30-to 40-mill range or even higher.

Nuclear power which offers convenience above all, and freedom from fuel supply problems, appears to have excellent prospects in these regions.

POTENTIAL NUCLEAR POWER LOCATIONS

Once the operational feasibility of nuclear power is demonstrated, acceptance throughout Canada will follow rapidly. Nuclear power will invade several types of mining operations. Coupled with the use of one of the new electrical ore-to-metal reduction processes now under development, it will be used extensively in opening the vast mineral resources which lie in the interior of the Canadian Shield and which are inaccessible by surface transport and lacking in local power sources. Next, there are the accessible, but power-poor regions which are scattered throughout eastern and northern Canada. Accessible, in this sense, means accessible at any price to bulk shipments

of coal or oil but power-poor with respect to cheap hydro power. Although theoretically hydro power potential is widespread in Canada, practical limitations include long transmission distances, excessive initial investment because a potential site may be too big to warrant exploitation for mining operations only, and unreliable flow at small hydro sites. Packaged nuclear power will permit growth in this area of about one new mining development per year during the 1960's.

Finally, nuclear power will invade the accessible, power-rich regions. This will be a phenomenon of the 1970's when convenience is a well-established sales feature and the cost of competitive sources of power begins to rise through depletion of fossil fuel reserves and full utilization of existing practical hydro sites.

The Inaccessible Regions

Mining exploration has barely skirted the edges of the Canadian Shield. Where exploration has penetrated, rich deposits of copper, nickel, lead, zinc, silver, gold, lithium, and many rarer metals have been found. The assumption is that the entire area is mineral rich. Although the terrain is rough, there are no large topographical features which would provide a reliable head for hydro development. This is fertile ground for nuclear power utilization. However, the same factors that prevent economical transport of conventional fuels into prospective mining sites also prevent outbound shipments of ore. Therefore, the full advantage of an interior location on the Shield would require coupling nuclear power with an electric process for reducing ore to metal so the product, as well as the fuel, could be airborne. Ore-reduction processes of this type are well along in their development.

Coppermine with its large deposits of medium grade ores provides an excellent example of the kind of development which may take place. It is located on the Arctic Shore where deep-sea ships are able to penetrate perhaps one out of every three years. The Northern Transportation Company has a long-range plan to extend its barge lines from the Mackenzie River along the Arctic Coast, but a barge trip from Coppermine through the Mackenzie River system to the present railhead at Waterways, Alta., is approximately 1,500 miles and probably could not be made in one season, since the navigation season along this route ranges from one month to four months. The projected extension of the railway to Pine Point on Great Slave Lake will shorten the trip by about 500 miles.

Other illuminating prospects in the Shield area are at Bathurst Inlet, where extensive nickel deposits have been found; Rankin Inlet, where a small operation is now producing nickel ore and where much larger opportunities await more convenient facilities; and the many gold finds on the western edge of the Shield. The Consolidated Discovery Gold Mine, 90 miles northeast of Yellowknife on Great Slave Lake, is working the richest gold ore in Canada but it is just at the margin of profitability. The Boreal mine on the north shore of Great Slave Lake taps the richest deposit of lithium in Canada, but it is now closed awaiting extension of the rail line to Pine Point on the south shore of the lake.

The Accessible, Power-Poor Regions

The regions which are accessible to bulk shipments of coal or oil, but short of hydro power, cover most of Canada outside of the areas served by the provincial power grids and the Shield region mentioned above. Ultimately, when the cost of fosil fuels rises, this region will provide a fertile maket for nuclear power. Meanwhile, comparative costs will dominate the decision-making.

These are diverse regions which extend from mountainous Yukon to the Maritime Provinces. No valid generalizations can be made so the character of the problems will be illustrated by critical examples.

Yukon

The mines with the highest power costs in Canada are the lead-zinc mine at Keno Hill in the Yukon and the Cassiar asbestos mine in northern British Columbia. Keno Hill is 300 miles from Whitehorse

by year-round road. It had a diesel power plant which cost 48 mills to opérate until it was abandoned in favor of a hydro-plant installed by the Northwest Territories Power Commission. Power from the 3,000 h.p. generator is used to full capacity in the mill and costs 26 mills. A second 3,000 h.p. generator will be installed and its power will be used for space heating and heating the penstock of the dam during the winter. At present, these facilities are heated by steam generated from coal which is brought in on the return trips of the ore trucks from the company coal mine at Carmacks. Installation of the second generator is expected to bring power cost to about 17 mills. Chief saving will be the elimination of the coal mine. The 17-mill figure is based on 20-year amortization of the $4¾-million investment in the hydro plant.

Power is generated at the Cassiar asbestos mine by diesel at an operating cost of 26 mills, not including amortization or other fixed charges. Oil is trucked in from Whitehorse via the Alcan Highway. This operation is profitable only because of the unusual high quality of the asbestos fiber produced. In spite of these difficulties, expansion continues. A new asbestos deposit is under development in the Yukon, approximately 100 miles north of Dawson; it may be a prospect for nuclear power.

Mackenzie River

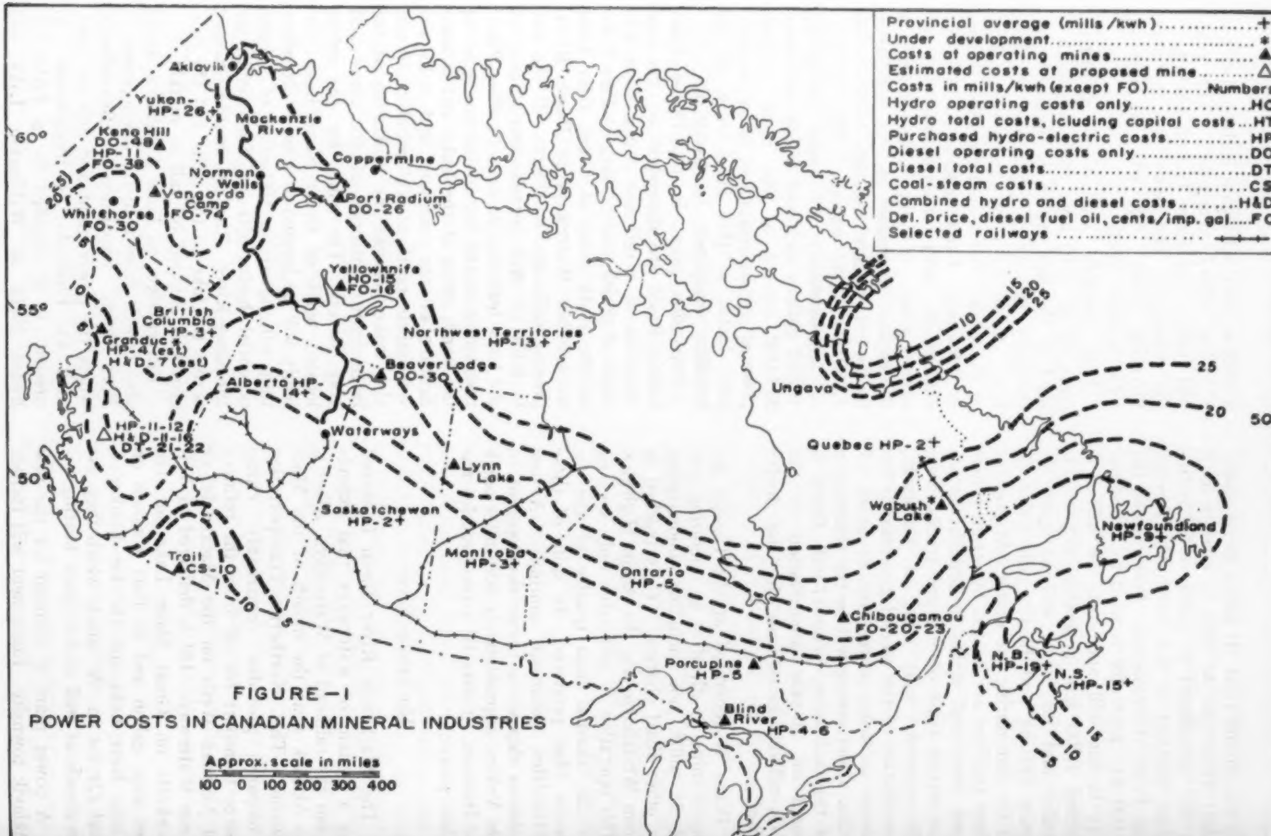
The Mackenzie River Basin is served by a system of waterways that extends from the railhead of Waterways, Alberta, to Aklavik near the mouth of the Mackenzie. The Northern Transportation Company provides remarkably cheap barge transport for oil from the refinery at Norman Wells on the Mackenzie, or from Waterways. Oil is delivered to Yellowknife on Great Slave Lake for 16c per imp. gallon and to Port Radium on Great Bear Lake for 26c for Bunker C and 22c for an "X" grade which they use in diesels as well as for space heating.

A power plant is planned for the new Aklavik townsite. Equipment will include a 600kw. oil-fired steam turbine and two 375 kw. diesel generators. The plant will furnish hot water central heating for the community and power for the water filtration plant. Oil will be obtained from Norman Wells.

Port Radium has diesel generating capacity of 3640 kw., 60% of which is used in the mill which is operated continuously and which constitutes the base load. About 25% of the power is used in the mine; the remaining 15% is used in the camp. Power cost is 20 mills, including oil, labor, maintenance, but not capital costs. A very large element in the capital investment at this installation is the oil storage capacity which totals 1,750,000 imp. gallons. This consists of approximately 17 tanks containing 100,00 gallons each and which cost about $15,000 erected at the mine. Diesel-powered mobile equipment is an insignificant factor at this mine since all ore handling equipment is electrified.

Expansion plans in the Upper Mackenzie Basin are dependent on the construction of a rail line across some 450 miles of prairie and muskeg to Pine Point on the south shore of Great Slave Lake from either Waterways to Peach River, present railheads in Alberta. If the line is built, it will permit development of the large lead-zinc deposits on Pine Point, re-opening of the Boreal lithium mine on the north shore of the Lake and intensification of the uranium and gold developments north of Yellowknife. It will also make possible the utilization of the large hydro potential of the Slave and Hay Rivers. The mills for the mines located north of Great Slave Lake probably will be located at Pine Point where they will be within 100 miles of a large potential hydro site at Fort Smith on the Slave River. Raw ore would be barged across the lake to the mills and the concentrates shipped by rail to market.

Beaverlodge, on Lake Athabasca would also benefit from a hydro development at Fort Smith. Expansion at Beaverlodge, where the power plant and mill are operated by Eldorado, is tremendous. At present, it is supplied by a 2,650 kw. hydro plant at Wellington Lake and



FIGURE—1

POWER COSTS IN CANADIAN MINERAL INDUSTRIES

2,100 kw. diesel generators; 10,000 kw. more is being added with the purchase of Cooper-Bessemer diesels. Within one year the decision must be made whether to build a new hydro plant to supply an additional 20,000 kw. The closest site of this size is 85 miles away and has a potential of 75,000 h.p. but is located in a wide valley which would require an excessive investment in a dam. Another, more favorable site is 110 miles away and has 50,000 h.p. potential. Critical factor in this decision is the necessity to amortize the investment in 9 years, since this is a uranium development and AEC purchasing contract will expire in that time.

Belcher Islands and Ungava Bay

Located in the southwest quadrant of Hudson's Bay, the Belcher Islands contain vast deposits of iron ore but, economically, lie in the margin between accessible and inaccessible regions. All fuels will have to be brought in by ship. Navigation in this part of Hudson Bay is unusually treacherous because of shoal water and bad weather. Hydro is out of the question since the highest relief on the islands is less than 150 feet with no drainage basins that could be dammed.

Prospects for nuclear power in the Ungava Bay region are quite good. Four large iron ore claims have been staked out on the west shore of the bay. The deposits are medium to low grade ore and will require benefication. Preliminary engineering work has started on a concentrating mill, town site, dock facilities, and a 20,000 kilowatt thermal power plant for one of the claims. During the open navigation season of less than four months in Ungava Bay, ore will be transported to an ice-free port in Greenland near Godthaab. When Ungava Bay is frozen, the ships will then concentrate on the long hauls to industrial markets.

It is expected that power can be made from an oil-fired plant for less than 10 mills/kwh. However, unusual obstacles will have to be overcome to meet this price. The navigation season in Ungava Bay is four months long at best; even then fog conditions are apt to make shipping hazardous for as many as two out of three days. In spite of this, the plan is to bring in a year's supply in large tankers and store it.

Maritime Provinces

Although these are among the most accessible regions in Canada power costs are extremely high. The major centers of new mining developments are Bathurst, New Brunswick, and the Gaspé Peninsula. Large base metals deposits are under development near Bathurst. (This is the region which pays 19 mills for its purchased power.) A new copper mine has been opened on the Gaspé Peninsula. Power is obtained through a 31-mile underwater transmission cable from the north shore of the St. Lawrence river.

Accessible, Power-Rich Regions

The major mining areas of Quebec, Ontario, and British Columbia are blanketed by the grid systems of the provincial power commissions. Power costs in these systems is usually 2 to 3 mills, and may go as high as 5 mills in the more remote locations. Small nuclear power plants will find acceptance in these areas only when the power commissions decide to decentralize. Today's trend is in the opposite direction. Even though Ontario has virtually exhausted its hydro potential (power from the St. Lawrence Seaway power plants already has been allocated and is inadequate for expected demand) Ontario Hydro is closing down its small plants (20,000 kw. more or less) because of the high cost of maintaining operating personnel at these plants. The same amount invested in coal for the new 400,000 kw. thermal plant in Toronto will produce far more power for the system. The only limiting factor on the expansion of this plant, which is located in the heart of the Toronto Metropolitan area, is the difficulty of getting right-of-way for additional transmission lines. Ontario Hydro's next thermal plant will be located outside of any metropolitan area to overcome this difficulty. Meanwhile, they are co-operating with the Canadian AEC in the construction of the

20,000 kw. nuclear demonstration plant on the Ottawa River.

Canada expects to benefit from the tremendous power potential of the Hamilton River in Newfoundland, despite its relative remoteness This is the last undeveloped large hydro source left in eastern Canada. Planned development will take about 10 years.

REFERENCES

1. Davis, J. and W.B. Lewis: An Economic Forecast ofthe Role of Nuclear Power in Canada; *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy*, Vol. 1, United Nations Organisation, New York, 1956, p. 346.
2. Davis, J. and W.B. Lewis: Electric Power in Canada: Regional Forecasts in Relation to Nuclear Power Possibilities; *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy*, Vol. 1, United Nations Organisation, New York, 1956, p. 166.
3. *United Nations Statistical Yearbook*, 1955, pp. 276 and 283.
4. *General Review of the Mining Industry, 1954*, Dominion Bureau of Statistics, Ottawa, p. A. 31.
5. *Water Power Resources of Canada*, Bulletin 2501, Water Resources Branch, Dept. of Northern Affairs and National Resources, Ottawa, 1956, p. 10.
6. *List of Principal Water-Power Developments in Canada*, Bulletin 2481, Water Resources Branch, Dept. of Northern Affairs and National Resources, Ottawa, 1955, pp. 1-9.

SHORTER COMMUNICATIONS — BRÈVES COMMUNICATIONS

CANADIAN CONFERENCE ON EDUCATION

Dr. Trevor Lloyd, President of the Canadian Association of Geographers, was the delegate of the Association to the above conference which was held from February 16th to 20th, 1958 at the Chateau Laurier in Ottawa, with panel meetings at other centres. The conference was convened by 19 organizations representing business men, trade unionists, veteran organizations, schools, universities, farmers and others. All of the provinces except Quebec were represented by their Ministers of Education. The delegates numbered about 850.

The conference was called because Canadians have, for some years, been alarmed at the lack of progress in education throughout the country, at the shortage of funds from private benefactors and the provincial and national governments, and at the relatively small proportion of qualified students reaching post-high school institutions. The aim of the conference was to recruit all national organizations behind a campaign for better education throughout the country at all age levels.

The conference opened with large plenary sessions which were followed by eight "workshop" units, some of which were themselves broken down into smaller groups. Each "workshop" approved of certain resolutions, many of which were later approved by the concluding plenary sessions. At the last of these, a continuing organization was set up to supervise the implementation of the decisions, to organize regional conferences and possibly another on a national scale in a few years time.

The "workshop" in which Dr. Lloyd participated dealt with post-high school education. This was under the chairmanship of the President of the University of British Columbia and included the presidents fo most Canadian universities, a considerable number of senior university administrators, business men and trade union leaders. In private conversation it was apparent that the status of geography is now generally accepted and only financial reasons prevent the establishment of departments of geography where they are now lacking.

N. L. Nicholson.

L'UNION GÉOGRAPHIQUE INTERNATIONALE

Le rapport du chef de la délégation canadienne du dix-huitième Congrès Géographique International vient d'être publié en anglais et en français. Le Dr B. Brouillette a été nommé président de la Commission de l'U.G.I. sur l'enseignement de la géographie dans les écoles de laquelle le Doyen N. Scarfe est également un membre. Le Prof. Theo. Hills a été nommé membre de la Commission de l'U.G.I. sur les tropiques humides tandis que le Dr. N. L. Nicholson membre correspondant de la Commission de l'U.G.I. sur les atlas nationaux.

CONFÉRENCE RÉGIONALE AU JAPON

La Conférence Régionale du l'U.G.I. fut tenue au Japon du 29 août au 3 septembre 1957. Soixante-quinze géographes étrangers représentant vingt pays différents assistèrent à cette réunion. Le docteur N. L. Nicholson délégué de l'Association était le seul représentant du Canada, bien qu'un membre de l'embassade canadienne à Tokyo, le Dr Gilles Lalande fut également inscrit. Les réunions des trois premiers jours eurent lieu à l'Université de Tokyo, tandis que l'Université de Tenri située à Nara, l'ancienne capitale du Japon durant la période de 710 à 784, recevait les délégués pour les troisderniers jours de la Conférence. Des excursions sur le terrain précédèrent et suivirent la rencontre, et quelques-unes d'entre elles durèrent sept à dix jours. Le docteur Nicholson présenta une communication intitulée *"Land Use Mapping in Canada"* et présida à une séance s'entretenant sur ce même sujet.

B. Brouillette.

IMPACT OF THE ST. LAWRENCE SEAWAY UPON SOUTHWESTERN PENNSYLVANIA *

The St. Lawrence Seaway will provide greatly increased facilities for commerce between the "heartland" of America and countries across the Atlantic Ocean. The economy of southwestern Pennsylvania will experience both favourable and unfavourable repercussions. The Seaway's construction period creates orders for steel and heavy equipment, and its opening will permit expanded coal and general cargo shipments. Of larger concern is the increase in competitive pressure between the lake cities and southwestern Pennsylvania in their efforts to attract new industry. This pressure may force the construction of a canal link from Pittsburgh to the Seaway at Lake Erie.

John L. Jenness.

ANAGLYPH MAPS *

Depicting relief of terrain on a flat surface of paper is one of the most difficult problems of cartography. The method chosen must allow accurate measurements and convey an impression of the topography. Contour line maps complemented with plastic shading constitute a good solution for many general purposes, although this method proves best when used over mountainous terrain. Stereoscopic maps, notably anaglyph maps, present an interesting solution, particularly suitable to some special purposes. Using the anaglyphic method three-dimensional maps, models and other illustrations can be included in books and other publications. The geometric relations pertaining to the construction of anaglyph maps are explained in this paper.

U. V. Helava.

NOUVEAU SYSTÈME DE RECONNAISSANCE DES GLACES DE DÉRIVE

Le Service de Géographie du Ministère des Mines et des Relevés Techniques d'Ottawa vient de mettre sur pied le long des côtes de l'Estuaire et du Golfe St-Laurent un système d'observation des glaces de dérive unique en son genre à la surface du Globe. Il s'agit en effet de la première série d'observations scientifiques (à fondement statistique) et systématiques de l'état des glaces à partir de points d'observation fixes sur le littoral et pour des tranches de distances déterminées à partir des rives. Les observations effectuées sont portées sur des formulaires uniformes et sont effectuées selon une méthode unique et synchronisée trois fois par jour aux mêmes heures: 8 h, 12 h et 15 h.

Des données sont recueillies: 1) sur l'état général du temps, l'intensité et le sens du vent, l'occurence de précipitation ou de brouillard; 2) sur l'état de la marée qui est un facteur capital dans la distribution de la glace; 3) en ce qui concerne la glace, deux facteurs principaux sont notés: a) sa concentration: soit la proportion exprimée en dixièmes de la glace par rapport à l'eau libre; b) la fragmentation: soit la dimension des morceaux de glace, exprimée en dixièmes par trois chiffres représentant respectivement trois différentes dimensions de glace.

Ces relevés ont tous été confiés à des observateurs ayant une longue expérience de la mer et une connaissance pratique des glaces: marins, gardiens de phares, pilotes retraités, etc.

L'analyse de ces observations permettra d'étudier de façon précise et documentée la dynamique des glaces de dérive dans l'Estuaire et dans le Golfe St-Laurent selon la conjoncture des autres facteurs en cause: température, vents dominants, courants de dérive, marées. Les résultats de ce premier hiver d'observation sont du plus haut intérêt: ils seront exposés de même que leur interprétation et les conclusions qui en découlent dans une étude de synthèse. Les relevés systématiques en cours n'ont pas qu'un intérêt d'ordre purement scientifique mais sont essentiellement effectués dans la perspective d'améliorer les conditions de navigation en hiver dans tout le Golfe et l'Estuaire du St-Laurent jusqu'à Québec, port que l'on prévoit devoir s'affirmer comme le grand terminus d'hiver de la navigation sur le St-Laurent. A partir des enseignements de cette première année d'observation, l'on envisage

* Abstract of a paper presented at the Seventh Annual Meeting of the Canadian Association of Geographers, Ottawa, 1957.

pouvoir prédire, grâce à la collaboration des Stations Météorologiques, les mouvements et l'état de la glace (concentration et fragmentation) deux ou trois jours à l'avance. Le rôle imparti au St-Laurent de s'imposer effectivement et de façon rentable et permanente comme une grande voie maritime d'hiver, jusqu'à Québec, au même titre que la Baltique en hiver à la latitude d'Helsinki et de Stockholm se verra en quelque sorte guaranti, du moins est-on fondé à l'espérer, par la poursuite de ces relevés systématiques de glaces au cours des années à venir.

Michel Brochu.

RESEARCH AT THE MCGILL SUB-ARCTIC RESEARCH LABORATORY *

Mineral exploration and the establishment of defence installations have assisted in making many new areas of Canada accessible to scientists of various disciplines. In particular, the development of the iron ore deposits at Knob Lake opened the relatively unknown interior of Labrador-Ungava. With the assistance of mining and construction companies, McGill University, in the summer of 1954, established a research laboratory at Knob Lake to serve as a centre for field studies of numerous sub-arctic problems. The expanded installation presently includes accommodation for thirteen men, the resident director's apartment, laboratories, library, dark room, radio room, two cabins for married personnel, and miscellaneous surveying and camping equipment.

The administration of the academic programme comes under the McGill Geography Department and the Faculty of Graduate Studies. The resident director leads a seminar and research programme for the five graduate students who spend a full year at the laboratory. During the summer additional staff and students, many from other departments and universities, join in an integrated research programme or conduct specialized studies of their own.

To date, most work has been in geomorphology, climatology, botany, and human and economic geography. Geomorphological studies have concentrated on aspects of glacial and post-glacial landforms and related phenomena. An analysis of preliminary observations of the complex pattern of glacial meltwater channels lends statistical support to theories of deglaciation which suggest that the rate of wastage of the Wisconsin ice rapidly increased at the close of the ice age. The location of the channels raises arguments as to the location of the last remaining sheets of dying ice. Studies of the patterns of glacial depositional features (moraines, eskers, drumlins, lake terraces) show the complexity of the Wisconsin glaciation in Labrador-Ungava. Studies in adjacent Archean intrusive and Proterozoic sedimentary rock reveal differences in response to weathering in sub-Arctic climates and point out variations in the mechanism and rate of slope-retreat in different rock types.

The distribution of late-lying snow banks, the occurence of permafrost, and actively forming soil polygons and associated soil structures emphasize the sub-Arctic climate of the region and merit continued investigation. Microclimatological studies, with particular emphasis on incoming short wave solar radiation, soil moisture, and evaporation, show that evapotranspiration from the floor of the lichen woodlands is about one third of the value expected according to Thornthwaite's theories.

The rôle of the lichen woodlands in the forest climax and its relationship to the close moss forests has received attention from several botanists. There is evidence that *Cladonia* lichens are invading the moss cover of the floor of the close forest. Other ecological and floristic studies have been made of the forest and tundra plant associations.

A study of the morphology of the "floating" string bogs shows that most strings of Sphagnum are actually anchored to or built up from the bog bottom. The rôle of permafrost in the formation of these as well as of the palsa bogs has been re-emphasized.

---

* Summary of a paper presented at the Seventh Annual Meeting of the Canadian Association of Geographers, Ottawa, 1957.

An analysis of the history of mineral development in Labrador-Ungava and studies of the community of Schefferville offer concrete examples of the problems of planning in sub-Arctic communities. They reveal important characteristics of the social conditions in northern mining and construction communities, including their effect upon the native population. A study showed the unreliability of even small scale agriculture under adverse soil conditions, but indicated that with care some root crops could be grown.

Detailed limnological studies were made at Astray Lake, fifteen miles southwest of Knob Lake, to assess its productivity and determine its characteristics as a habitat of the chironomids and other littoral invertebrates. Ornithological work revealed new data on the nesting habits and life history of several bird species, especially the white crowned sparrow and rock ptarmigan.

The Laboratory provides facilities and, in some cases, the personnel to other universities, government agencies and private companies for the conduct of routine observational programmes. All permanent personnel are engaged in the operation of a first order meteorological observing station for the Department of Transport. Other programmes include a study of the properties of snow and of lake ice for the National Research Council and the Department of Transport. A portable field seismograph was installed by the Dominion Observatory. Observations over eighteen months show that seismic activity in this part of the Canadian Shield merits the installation of a larger three-component seismograph and the inclusion of Knob Lake in an expanded network of recording stations.

Dartmouth College, in its Ionosphere Research Station at the Laboratory, has been conducting a series of measurements of oblique incidence, whistler activity and related ionospheric phenomena. As part of the International Geophysical Year a magnetometer and all-sky camera have been added to this equipment. Also in this regard, the Radio Wave Propagation Laboratory of Stanford University initiated an extensive programme for the measurement of backscatter.

These and other investigations in the last three years have raised as many questions as they answered and further research in all fields is urgently needed. A concentrated study of glacial geomorphology with the aim of further unravelling the history of the Wisconsin glaciation of Labrador-Ungava has already been started by the present Field Director of the Laboratory, Dr. J. D. Ives.

The Supplements to the Annual Reports for 1955-56 and 1956-57, of the Laboratory (mimeo, 1957 and 1958), contain articles by staff and students on research conducted at the Laboratory. In addition, 5 Master's theses and one Ph.D. thesis have been completed and 4 are being written on such research and six papers have been published in scientific journals.

R. N. Drummond.

ÉTUDE PRÉLIMINAIRE SUR LE FRASIL DANS LES EAUX DU SAINT-LAURENT

Du 7 février au 15 mars de l'hiver 1958, une étude préliminaire sur la présence du frasil (masse ou bouchons de cristaux de glace dans une eau en surfusion) a été effectuée dans les eaux du St-Laurent à la hauteur de Québec, sous la direction du soussigné, pour le Service de Géographie d'Ottawa, et de G. E. Jarlan, pour le Laboratoire d'Hydraulique du Conseil National des Recherches.

Les prises d'échantillons ont été faites à bord du brise-glace Montcalm à diverses profondeurs entre la surface et 30 m., à l'aide d'une trappe à plancton. A Québec et même aux températures les plus froides de l'hiver 1958 qui ont eu lieu en février, et contrairement à ce qui se passe dans la région de Montréal, aucune présence de frasil n'a été notée de la surface aux profondeurs intermédiaires.

Ces recherches, qui ont été conduites à la fois pour des fins scientifiques et dans le but de vérifier jusqu'à quel point le frasil pouvait nuire au mouvement des navires au cours de l'hiver, ont démontré que ce type de glace ne présente pas de problème sérieux en raison de son extrême

rareté, mais que, par contre, la présence de masses de glace en bouillie flottant en surface dans l'Estuaire constituait pour leur part, un danger certain et assez fréquent d'engorgement des prises d'eau des navires.

Michel Brochu.

SENATE COMMITTEE ON LAND USE

The Special Senate Committee on Land Use in Canada met at the Geographical Branch, Department of Mines and Technical Surveys on December 5th, 1957, in order to hear of the work that the Branch was carrying out in land-use mapping, to see some of the results achieved so far and to become acquainted with similar work already done by geographers in other parts of the world. The brief presented by the Branch Director was published in both French and English.

B. Cornwall.

THE PLANNING UNIT: THE CONFLICT OF THEORETICAL AND PRACTICAL FACTORS *

Regional planning, to be effective, must have a legal procedural basis. The geographer in his applied field of problem solving often deals with an overlapping complex of legal jurisdictions. The regional approach in applied geography is related directly to a problem to be solved and the geographer's solution to a regional problem must permit fragmented juristictional authorities to blend together for a unitary objective. Not only are the customary three levels of government (federal, provincial, municipal) involved but usually within each level conflicting legal jurisdictions overlap. Many regional

* Abstract of a paper presented at the Seventh Annual Meeting of the Canadian Association of Geographers, Ottawa, 1957.

The Committee in the Geographical Branch. This was an historic occasion as it was the first time that a Senate Committee had met in a government department. The Chairman, the Honorable C. G. Power, is on the right, nearest the camera.

problems have international ramifications to complicate procedures further.

The province of Ontario has general and special legislation setting out boundaries necessary to carry out special purposes of specific acts as well as to promote the general conduct of governmental business and administration. Specific Ontario legislation extremely interesting to the geographer includes the Planning Act, the Conservation Authorities Act and the Water Resources Commission Act. An analysis of the application of specific legislation to general administrative legislation and practice at the federal, provincial and municipal level enables the geographer to undertake regional planning in a three-dimensional mosaic of complementary and overlapping governmental responsibilities. Theoretical and practical divisions of responsibilities, including financial grants, must be worked out.

E. G. Pleva.

H7 Cont.

89 IMPRIMERIE "LE DROIT", OTTAWA CANADA